2020 MOLALLA STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION

City of Molalla – Public Works Department

117 N. Molalla Ave., Molalla, OR 97038

These Standards were compiled by information obtained from, or input received from the following sources:

American Association of State Highway and Transportation Officials
American Public Works Association
American Water Works Association
Asphalt Institute
City of Wilsonville Public Works Standards
City of Beaverton Public Works Standards
City of Gresham Public Works Standards
City of Hillsboro Public Works Standards
City of Portland Public Works Standards
City of Tualatin Public Works Standards
CleanWater Services Agency of Washington County
King County, Washington
Oregon Department of Environmental Quality
Oregon Department of Fish and Wildlife
Oregon Department of Transportation
Oregon Health Division
Portland Cement Association
Portland General Electric
Stormwater Management Manual for Western Washington
Tualatin Valley Fire and Rescue
Tualatin Valley Water District Water System Standards
Washington County Department of Land Use and Transportation
Water Environment Services of Clackamas County

STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION

FOREWORD

The 2020 edition of the City of Molalla Public Works Standards will provide the technical engineering design and construction information standards for all Public Works transportation projects, storm system projects, sanitary sewer projects, and water distribution system projects in the interest of health, safety and welfare of the residents of the City of Molalla. These Public Works Standards – 2020 will supersede all previously issued Standard Specifications. Interpretation and enforcement of these standards shall be the responsibility of the City of Molalla Public Works Department.

All federal, state, county or local laws and ordinances are to be adhered to. If there is any conflict between the Standard Specifications and pertinent laws and ordinances, the laws and ordinances shall prevail.

REVISIONS TO STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION

Revision 06/17/20

3.4.3 – Water Quantity Facility Design Standards. Clarification of the term predeveloped.

Revision 03/12/21

2.2.27 Curbs and Grading Outside of Street

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SECTION 1 – GENERAL CONSTRUCTION & ADMINISTRATIVE REQUIREMENTS

1.1 AUTHORITY AND PURPOSE OF STANDARDS

The Molalla Comprehensive Plan addresses land use and development issues within the City. This planning document is a single document with references to many City Ordinances. The Molalla Comprehensive Plan and Subdivision Ordinance regulate the divisions of land and the creation of public facilities. The design standards in Section 17 and 21 of the Molalla Municipal Code discussed generalized public facility design requirements.

The purpose of these standards is to provide a consistent policy under which certain physical aspects of public facility design will be implemented. Most of the elements contained in this document are Public Works oriented and it is intended that they apply to both public improvements under City contract and public improvements under private contract designated herein.

These Standards for Public Improvements cannot provide for all situations. They are intended to assist but not substitute for competent work by design professionals. It is expected that engineers will bring to each project the best of skills from their respective disciplines. The Standards for Public Improvements are also not intended to limit unreasonable any innovative or creative effort which could result in better quality, better cost savings, or both. Any proposed departure from the Standards for Public Improvements will be judged, however, on the likelihood that such variances will produce compensating or comparable results, in every way adequate for the user and City residents.

Alternate materials and methods will be considered for approval by the Public Works Director as the need arises and conditions warrant modification. This consideration will be on a case-by-case basis and require sufficient justification prior to approval.

1.2 INTENT OF STANDARDS

These standards for constructing public facilities in the City of Molalla are intended to protect the public health, safety, and welfare by:

- Setting forth uniform design, material, and workmanship standards.
- Supplementing and completing the public health and safety requirements of the Molalla Municipal Code.
- Streamlining the administration and construction of public facilities in the City and minimizing repairs, maintenance, and operation to these public facilities.
- Although these Standards are intended to provide requirements for design and construction of public facilities, invariably situations will arise that are not clearly covered by these Standards. In these situations, the City Public Works Department will review the issue on a case-by-case basis to determine the design and/or construction methodology acceptable to the City.

Nothing in these standards shall relieve any person or organization from the obligation to comply with the applicable laws, rules, and regulations of any federal, state, and local authority.

1.3 SCOPE OF STANDARDS

These standards for construction of public facilities in the City of Molalla:

a. Cover all public streets, public easements, drainage, water, sewer, and appurtenant facilities inside the corporate limits of the City that are to be turned over to the City for maintenance and operation.
b. Relate only to public facilities constructed in the City and should not be confused with building codes, zoning ordinances, and other regulations for which the City has established separate procedures and standards.
c. In accordance with Molalla Municipal Code 12.12, the Public Works Director shall have the authority to modify the Standards and Standard Detail Drawings as needed to address changes in departmental operation and maintenance needs, technology, material standards, agency permitting requirements, and state or federal rules and regulations.

1.4 ENGINEERING POLICY

It shall be the policy of the City of Molalla to require compliance with Oregon Revised Statute Chapter 672 for professional engineers and land surveyors.

All engineering plans, reports, or documents shall be prepared by a registered professional engineer, or by a subordinate employed under the engineer's direction, and shall be signed by the engineer and stamped with the engineer's seal to indicate the engineer's responsibility for them. It shall be the engineer's responsibility to review any proposed public facility extension, modification or other change with the City, prior to engineering or proposed design work, to determine any special requirements or whether the proposal is permissible. A "Preliminary Review" and/or a "Plans Approved for Construction" stamp of the City, on the plans, etc., for any job, does not in any way relieve the engineer of the responsibility to meet all requirements of the City or obligation to protect life, health, and property of the public. The plan of any project shall be revised or supplemented at any time it is determined that the full requirements of the City have not been met.

1.5 APPLICABILITY

These Standards for Public Improvements shall govern all construction and upgrading of all public and privately financed public facilities in the City of Molalla and application work within its service areas.

1.6 AVAILABILITY OF STANDARDS

Copies of these Standards for Public Improvements for the City of Molalla, Oregon are available to download from the City of Molalla website. Hard copies will be made available for pick up at the Office of the Public Works Director given reasonable notice and payment of current reproduction costs.

1.7 REVISIONS TO DESIGN STANDARDS

It is anticipated that revisions to the Standards for Public Improvements will be made from time to time. The date appearing on the bottom of each page is the date of latest revision. Users should apply the latest published issue to the work contemplated.

Parenthetical notations at the end of the sections indicate the most recent change to those sections. All sections without notations are from the original Standards for Public Improvements as adopted. Some sections may be changed more than once and it shall be the user's responsibility to maintain his/her copy of these Standards for Public Improvements. Published revisions or updates can be found on the City of Molalla Public Works website.

1.8 REFERENCE TO STANDARDS

The design engineer may, at their sole discretion, use the standards by direct reference in the contract documents prepared for the construction of any public street, stormwater, water, and

sewer facilities in the City of Molalla. If the design engineer incorporates the City's standards in that way, the contract documents shall contain the following statements:

- Material and workmanship shall be in strict accordance with the standard specifications of the City of Molalla. No changes from the approved project plans and specifications shall be made without approval of the City Public Works Department.
- The standards are in outline form only and shall not operate to relieve the Design Engineer or Contractor of his or her professional responsibilities during project design and construction.
- These standards represent the minimum requirements for construction in a public right-of-way or public easement to protect the public health, safety and welfare. Any deviation from the standards must be approved, in writing, by the City Public Works Department.

1.9 ORDER OF PRECEDENCE

All federal, state, county or local laws and ordinances are to be adhered to. If there is any conflict between the Standard Specifications and pertinent laws and ordinances, the laws and ordinances shall prevail.

If there is a conflict between approval documents, the document highest in precedence shall control. The precedence shall be:

First: Permits from other agencies or jurisdictions, as may be required by law.

Second: Land use decision-making authority's Conditions of Approval.

Third: City of Molalla master plans (latest editions): Transportation Systems Plan, Stormwater Master Plan, Wastewater System Master Plan, Water System Master Plan, Parks and Recreation Master Plan.

Note: *Permits, Land Use Conditions of Approval, and Master Plans are intended to provide the authority for what public facilities are to be constructed; the below public works detail drawings and standards and the various standards that follow describe how public facilities are to be constructed through the use of the approval component materials equipment, and methods set forth.*

Fourth: City of Molalla Standard Detail Drawings.

Fifth: City of Molalla Standard Specifications for Public Works Construction.

Sixth: Oregon Standard Specifications for Construction (current edition) (ODOT, Oregon APWA) and any reference specifications and standard practices adopted by nationally recognized professional societies such as ASCE, AWWA, APWA, ACI, ASTM, and AASHTO, and any reference specifications or guidelines as presented in the MUTCD, latest edition.

Seventh: ODOT Pavement Design Guide.

Eighth: Americans with Disabilities Act latest approved standards or guidelines as referenced in the Standard Details of these Standards.

Ninth: Plans and details prepared by the design engineer.

Supplemental written agreements, franchise agreements, and approved revision to plans and specifications by the appropriate jurisdictions and conforming to local, state, and federal law will take precedence over documents listed above. Detailed plans shall have precedence over general plans. In any event, the determination of the Public Works Director shall be final.

1.10 SCOPE OF STANDARDS

These standards for construction of public facilities in the City of Molalla:

- Cover all public streets, public easements, drainage, water, sewer, and appurtenant facilities inside the corporate limits of the City that are to be turned over to the City for maintenance and operation.
- Relate only to public facilities constructed in the City and should not be confused with building codes, zoning ordinances, and other regulations for which the City has established separate procedures and standards.
- In accordance with Molalla Municipal Code 12.12, the Public Works Director shall have the authority to modify the Standards and Standard Detail Drawings as needed to address changes in departmental operation and maintenance needs, technology, material standards, agency permitting requirements, and state or federal rules and regulations.

1.11 APPROVAL OF ALTERNATE MATERIALS OR METHODS

Any Substitution material or alternate method not explicitly approved herein will be considered for approval as set forth in Section 1.1. Persons seeking such approvals shall make application in writing. Approval for any deviation from these Standards for Public Improvements will be in written form. Approval for minor matters will be made in writing if requested.

Any alternate must meet or exceed the minimum requirements set in these Standards for Public Improvements.

The written application is to include, but is not limited to, the manufacturer's specifications and testing results, design drawings, calculations, reason and justification, and other pertinent information.

Any deviations or special problems shall be reviewed on a case-by-case basis and approval by the Public Works Director. When requested by the City, full design calculations shall be submitted for review with the request for approval.

1.12 SPECIAL DESIGN PROBLEMS

Special applications not covered in these Standards for Public Improvements require review and approval by the Public Works Director. Submittal of full design calculations, supplemental drawings and information will be required prior to any approval.

Applications requiring special review and approval may include, but are not limited to, the following:

- Sewer Force Mains
- Relining of Existing Sewers
- Internal Sealing of Existing Sewers
- Sewer Regulatory Devices
- Sewage Pump Stations
- Sewer Siphons
- Sewage Treatment Plants
- Sewer Flow Measurement/Monitoring Device
- Water Distribution Pump Stations
- Water Pressure Regulating Devices
- Energy Dissipaters
- Water Reservoirs
- Water Treatment Plants

- Water Flow Measurement/Monitoring
- Stormwater Facilities
- Stormwater Detention Facilities

1.13 ACRONYMS AND DEFINITIONS

The following is a list of acronyms used throughout these standards:

AASHTO – American Association of State Highway and Transportation Officials
AC – Asphaltic concrete
ACI – American Concrete Institute
ACPA – American Concrete Pavement Association
ADA – Americans with Disabilities Act
ADAAG – Americans with Disabilities Act Accessibility Guidelines and Standards
ADT – Average daily traffic
ANSI – American National Standards Institute
APWA – American Public Works Association
ASTM – American Society for Testing and Materials
AWWA – American Water Works Association
CDF – Control density fill
CFS – Cubic Feet per Second
CEC – Cation exchange capacity
CLSM – Controlled Low-Strength Material
CN – Curve number
DBH – Diameter at Breast Height
DEQ – Oregon Department of Environmental Quality
FEMA – Federal Emergency Management Agency
FHWA – Federal Highway Administration
HMAC – Hot Mixed Asphaltic Concrete
MUTCD – Manual on Uniform Traffic Control Devices, latest edition.
NAVD 88 – North American Vertical Datum of 1988: the vertical control datum established in 1991 by the National Geodetic Survey.
NEMA – National Electrical Manufacturers Association.
NGVD 29 – National Geodetic Vertical Datum of 1929: vertical control datum established for vertical control in the United States by the general adjustment of 1929 (formerly called the "Sea Level Datum of 1929").
NPSH – Net Positive Suction Head, in association with sanitary sewer pumping units.
NRCS – National Resource Conservation Service
ODFW – Oregon Department of Fish and Wildlife
ODOT – Oregon Department of Transportation
ODOT QPL – Qualified Products List; published twice each year by ODOT's Construction Section.
ODOT SSC – Oregon Department of Transportation Standard Specifications for Construction, 2015, or latest edition.
OSHA – Occupational Safety and Health Administration
PCA – Portland Cement Association
PCC – Portland Cement Concrete
PRTMP – Current edition of the City of Molalla's Parks, Recreation and Trails Master Plan.
PUE – Public Utility Easement
SBUH – Santa Barbara Unit Hydrograph
SCS – Soil Conservation Service, U.S. Department of Agriculture
TSP – The latest edition of the City of Molalla's Transportation System Plan.
USCGS – United States Coast and Geodetic Survey

WQV – Water Quality Volume

The following is a list of definitions that apply to these standards:

ACT OF GOD – Earthquake, flood, cyclone, or other cataclysmic natural phenomenon

ADDENDUM – Written or graphic modification or interpretation of contract documents.

AGREEMENT – Written agreement covering performance of work and furnishing of labor and materials in construction of work.

ALLEY – A public access easement or right-of-way not more than 20 feet and not less than 12 feet in width which intersects with a public street. Primarily intended to provide secondary access to road or side of lots or buildings and not intended for normal through vehicular traffic.

APPLICANT – Person, organization, or duly authorized representative identified as such in specifications and in agreement and referred to throughout contract documents as if singular in number and masculine in gender; means owner or authorized representatives, including parties acting as designated authority for aspects of work.

APPROVE – "Approved," "approve," "approval," or similar words shall mean to give, in writing, limited, conditional, or qualified permission to use material, equipment, or methods, such conditions being in strict compliance with City's standards; approval will be by the Public Works Director or their authorized representative.

APPROVED BACKFLOW PREVENTION DEVICE – A device that has been investigated and approved by the Oregon State Health Division.

ARCPACS – A federation of certifying boards in agriculture, biology, earth, and environmental sciences. Provides professional certification for soil scientists whose education, experience and career path are in some aspect of the soil science profession and can meet the standards of the ARCPAC program

ARTERIAL STREET – A Street intended to carry large volumes of traffic at steady speeds with minimum interruptions to traffic flow.

AS-BUILT PLANS – See Record Drawings.

AUTHORIZED REPRESENTATIVE – Party or parties authorized or employed by applicant to observe, test, or review quality and sufficiency of work performed, materials used, and determine compliance with plans and specification.

BACKFLOW – The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any sources other than its intended source.

BACKFLOW PREVENTER – A device or means to prevent backflow into the potable water system.

BACK SIPHONAGE – The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel into a water supply pipe due to a negative pressure in such pipes.

BID BOND – Form of security furnished by Contractor, guaranteeing that he/she will enter into a contract in accordance with contract documents if the proposal is accepted.

BIDDER – Any individual, firm, or corporation formally submitting a proposal for work contemplated, or any part of it, acting directly or through an authorized representative.

BIKE LANES – A designated travel-way for bicyclists which is located within the roadway directly adjacent to the outside vehicular lane or on the shoulder.

BIKE ROUTE – A designated travel-way for bicyclist which is shared with vehicular traffic. The roadway is designated with signs for bicycling (no pavement markings for the bike route or delineation of parking spaces are used).

BIOENGINEERING – A construction methodology used to stabilize and conserve soils through the use of live plants alone or in combination with biodegradable material to produce living, functioning systems that can prevent erosion, control sediment, and provide habitat.

BUILDING SERVICE LATERAL – A public sanitary sewer beginning at the property line or public utility easement line and extending to the sanitary sewer main.

BUILDING SEWER – A private sanitary sewer beginning five (5) feet outside the building and extending to the property line or public easement line, connection to the building service lateral.

BUILDING SUPPLY – The pipe carrying potable water from the water meter or other source of water supply to a building or other point of use or distribution on the lot. Building supply shall also mean customer line.

CERTIFICATE OF INSURANCE – Evidence of insurance coverage of the Contractor, furnished to the City.

CHANGE ORDER – Written order to Contractor by Public Works Director or their City's authorized representative approving the addition, deletion, or revision of work within general scope of contract, or adjustment in price or time.

CITY – City of Molalla

CITY AUTHORIZED REPRESENTATIVE – Party or parties authorized or employed by the City of Molalla to observe, test, or review quality and sufficiency of work performed, materials used, and determine compliance with plans and specification. The designated authority shall be the Public Works Director or their authorized representative.

CITY COUNCIL – Seven-member policy making and legislative body responsible for identifying community needs and establishing community policies and goals.

COLLECTION SYSTEMS – Facilities maintained by the City of Molalla connected thereto for the collecting, pumping, conveying, and controlling of wastewater.

COLLECTOR SEWER – The portion of the public sewerage system which is primarily installed to receive waste water directly from individual residences and other individual public or private structures.

COLLECTOR STREET – Street which forms the boundary of major blocks of land and is intended primarily for inter-neighborhood traffic; can function as a road to service areas from the arterial system.

CONTRACT – Binding agreement between the Contractor and applicant or the Contractor and City covering performance of work and furnishing of labor and materials for construction of public facilities.

CONTRACTOR – The person or entity that has entered into contract with the applicant or City; "Contractor," though here used to describe an individual, shall mean Contractor, agents, employees, officials, subcontractors, or anyone connected with work set forth on behalf of Contractor.

CONTRACT DOCUMENTS – Agreement, addenda, instructions to bidders, Contractor's proposal, bonds, notice of award, notice to proceed, general provisions, technical provisions, plans, change orders, field orders, and all other modifications of such documents entered into in accordance with contract.

CONTRACT PRICE – Total amount payable to Contractor for work, including all sales, use, and other consumer taxes related to work.

CONTRACT TIME – Number of calendar days allowed Contractor to complete work.

CONSTRUCTION MAINTENANCE ASSURANCE – A one-year maintenance assurance, for 20% of the cost to construct public improvements, required by the City for work performed to ensure post-construction quality and survivability.

CORE – To cut and remove a circular portion of concrete, pavement, pipe or soil

COUNTY ROAD – Public road incorporated into county roadway system by formal action of Board of County Commissioners; these roads are assigned numbers and county assumes maintenance responsibility.

CROSS CONNECTION – Any connection or arrangement, physical or otherwise, between a potable water supply system and any plumbing fixture or any tank, receptacle, equipment or device through which it may be possible for non-potable, used, unclean, polluted and

contaminated water, or other subsurface, to enter into any part of such potable water system under any condition.

CUL-DE-SAC – A dead-end street having a turnaround area at the end.

CURB – The line indicating the edge of the vehicular roadway within the overall right-of-way.

CUT SHEETS – Sheets of tabulated data, indicating stationing, structures, fittings, angle points, beginning of curve, points on curve, end of curves, storm drain slope, staking offset, various elevations, offset cuts, and storm drain depths for streets, water lines, sanitary sewers, and storm drains.

DATUM – The vertical elevation control for the City of Molalla is based on Oregon Department of Transportation datum.

DEAD-END STREET – A Street or series of streets which can be accessed from only one point. Dead-end streets can be either temporary (intended for future extension as part of a future street plan) or permanent. Permanent dead-end streets must provide adequate turnaround capability.

DESIGN ENGINEER – Professional Engineer registered in the State of Oregon responsible for planning, designing, and producing record drawings of public facilities that will be accepted and owned by the City.

DESIGNATED ARTERIAL OR COLLECTOR STREET – A Street designated as an arterial or collector in the Transportation System Plan.

DETAIL DRAWINGS – Construction drawings produced or approved by the City of Molalla providing details of acceptable construction standards for public facilities. Drawings may be periodically updated or changed, as needed, by approval of the Public Works Director.

DETENTION – The holding of runoff for a short period of time and then releasing it to the natural water course where it returns to the hydrologic cycle.

DEVELOPMENT – Development includes new development, redevelopment, and/or partial redevelopment.

DIRECTED, REQUIRED, ETC. – In these standards, “directed,” “required,” “permitted,” “ordered,” “designated,” or similar words shall mean at the direction, requirement, permission, order, or designation of applicant or Public Works Director.

DOMESTIC SEWAGE – The liquid and waterborne waste derived from the ordinary living processes, free from industrial wastes, and of such character to permit satisfactory disposal, without special treatment into the public sewer or by means of private sewage disposal system.

DOUBLE CHECK VALVE ASSEMBLY – An assembly composed of two single, independently acting, approved check valves, including tightly closing shut-off valves located at each end of the assembly and fitted with properly located test cocks.

DOUBLE CHECK DETECTOR CHECK VALVE ASSEMBLY – A line-sized approved double check valve assembly with a parallel meter and meter-sized approved double check valve assembly. The purpose of this assembly is to provide backflow protection for the distribution system and at the same time provide a metering of the fire system showing any system leakage or unauthorized use of water.

DRAINAGE FACILITIES – Pipes, ditches, detention basins, creeks, culvert bridges, etc., used singularly or in combination with each other for the purpose of conveying or storing storm water runoff.

DRAINAGE WASTE – Storm water, ground water, surface drainage, subsurface drainage, spring water, well overflow, roof drainage, or other like drainage other than sewage or industrial waste.

DWELLING UNIT – A facility designed for permanent or semi-permanent occupancy and provided with minimum kitchen, sleeping, and sanitary facilities for one family.

EASEMENT – An interest in land owned by another that entitles the easement holder to a specific limited use of the land; however, ownership of the land does not change.

EASEMENT, PUBLIC PIPELINE – The space identified within the easement document that is in, upon, above, along, across, over or under the publicly owned and maintained storm, sanitary, or water facility.

EASEMENT, PUBLIC UTILITY – The space in, upon, above, along, across, over or under the easement as identified within the easement document. By way of general description, public utility easements are typically created along the border(s) of a tax lot or frontage along public right-of-way and are intended for the use of private utility companies and other authorized users to operate, place, relocate and maintain facilities in accordance with city requirements and standards.

ENGINEER – The engineer, including the City's engineer, licensed by the State of Oregon as a Professional Engineer under whose direction plans, profiles, and details for the work are prepared and submitted to the City for review and approval, or who is in charge of and responsible for construction management of the improvement.

EPPDM PLANNING AND DESIGN MANUAL – Erosion Prevention Planning and Design Manual developed in partnership between Clean Water Services of Washington County, Water Environment Services of Clackamas County, City of West Linn, ODOT, and Harza Engineering, 2000 or latest edition.

EXPANSION JOINT – A joint to control cracking in the concrete surface structure and filled with preformed expansion joint filler or approved joint seal material.

FIELD ORDER – Written order to Contractor, approved by applicant or City, changing work but not affecting contract price or time.

FINAL COMPLETION – Date when project correction list is completed; a 20% maintenance assurance is submitted in accordance with contract documents, as modified by change orders agreed to by parties, or as specified in "Project Closeout" and the City's authorized representative receives confirmation that all easements and legal documents have been recorded with the County Recorder.

FIRE HYDRANT ASSEMBLY – The fire hydrant and attached auxiliary valve.

FIRE PROTECTION SERVICE – A metered connection to the public water main intended only for the extinguishment of fires and the flushing necessary for its proper maintenance.

FIRST PARTY – Applicant or duly authorized representative.

FRENCH DRAIN OR LEACH LINE – A covered underground excavated trench filled with washed gravel that surrounds a perforated delivery pipe used to receive storm water wherein the sides and bottom of the trench are porous, permitting the storm water to seep into the ground.

GRADE – The degree of inclination of a road or slope.

GROUT – Thin, fast-setting, high-strength, non-shrink mortar used to fill cracks and joints in masonry.

HYDRANT LEAD – The water line connecting the fire hydrant to the auxiliary valve on the City distribution main.

IMPERVIOUS AREAS – Those hard surface areas, including existing gravel surfaces, located upon real property which either prevent or retard saturation of water into the land surface and cause water to run off the land surface in greater quantities or at an increased rate of flow from that present under natural conditions preexisting to development.

INCLEMENT WEATHER – Weather conditions so extraordinary that previous climatic conditions in locality of work give no reasonable warning of them; shall be determined by Public Works Director.

INDICATED, SHOWN, ETC. – "Indicated," "noted," "shown," "called for," or similar words shall mean indicated, noted, shown, or called for in the contract documents for the referred work.

INDUSTRIAL WASTE – Solid, liquid, or gaseous waste resulting from any industrial, manufacturing, trade, or business process or from development, recovery, or processing of natural resources.

INTERSECTION – Area jointed by two or more roads intersecting; for design purposes, intersection is not formed by naming two approaches of continuous street at curve or other point with different street names.

INTERCEPTOR (GREASE, OIL, AND SAND) – A device designed and installed so as to adjust, separate, and retain deleterious, hazardous, or undesirable matter from sewage, and to permit normal sewage or liquid wastes to discharge into the disposal terminal.

INTERCEPTOR SEWER – The primary public sanitary sewer which conveys waste water directly into the Waste Water Treatment Plant.

IRRIGATION SERVICE – A metered connection intended for seasonal use and delivering water which are not discharged to the sanitary sewer.

LANDSCAPE MAINTENANCE ASSURANCE – A two-year maintenance assurance for 100% of the cost to install all required landscaping in water quality/quantity facilities and vegetated corridors, plus 100% of the cost to maintain the landscaping in these areas for two years.

LARGE-DIAMETER PIPE – Pipe with inside diameter larger than 24 inches.

LATERAL SEWER – See Building Service Lateral.

LOCAL OR RESIDENTIAL STREET – A Street designated to provide vehicular access to abutting properties and discourage through traffic.

LONGITUDINAL JOINT – A joint which follows a course approximately parallel to the centerline of the roadway.

MAINTENANCE ASSURANCE BOND – Maintenance assurances required by the City of work performed to ensure post-construction quality and landscape survivability. May consist of both construction maintenance assurance and landscape maintenance assurance.

MAJOR PARTITION – A partition which includes the creation of a road or street.

MAJOR TREES – Trees within the right-of-way are those which have a caliper of 4" or larger. Street improvement plans will identify major trees by location, caliper, and species. Major tree species are those which contribute to the landscape character of the area to include: Douglas fir, Cedar, Redwood, Sequoia, Oak, Ash, Birch, Walnut, and Maple. The identification of major trees should distinguish species generally suitably for retention adjacent to streets and those species with growth habits that create nuisances, unusual maintenance problems, or hazards to the public. Major trees exist in clusters, groves or rows within the right-of-way.

MANUFACTURER'S NAME – Any manufacturer's name, specification, catalog, number or type used herein is specified by make and order to establish the standard requirements of the City. Other equivalent makes will be considered for approval, providing they are comparable with this established standard.

MINOR PARTITION – A partition which does not include the creation of a road or a street.

MORTAR – Plastic building material of cement or lime, sand, and water that hardens in place and is used in masonry or plastering.

NATURAL GRADE – The grade of the land in an undisturbed state.

NOTICE TO PROCEED – Written notice given by designated authority to Contractor fixing date when Contractor shall begin to perform the obligations under contract documents.

O&M PLAN – Operation and maintenance plan designed for public facilities and prepared by the design engineer, manufacturer, and/or Contractor.

ON-SITE DETENTION – The storage of excess runoff on the development site prior to its entry into a public storm drain system and gradual release of the stored runoff after the peak of the runoff has passed.

OR EQUAL – "Or equal," "or approved equal," or similar words shall mean to possess same performance qualities and characteristics and fulfill utilitarian function without any decrease in quality, durability, or longevity and shall meet with approval of designated authority (no inference is intended that items must be identical in all respects if above conditions are satisfied).

OWNER – The owner of record of real property as shown on the latest tax rolls or deed records of the County and includes a person who furnishes evidence that he/she is purchasing a parcel of property under a written recorded land sale contract.

PARTITION – To divide an area or tract of land into two or three parcels within a calendar year when such area or tract of land exists as a unit or contiguous units of land under single ownership at the beginning of such year.

PAYMENT BOND – Form of security furnished by Contractor and their surety guaranteeing payment of all labor, material, equipment, and all other obligations arising from work.

PEAK RUNOFF – The maximum water runoff rate (CFS) determined for the design storm.

PERFORMANCE BOND – Security furnished by applicant, or such other party acceptable to the City, and their surety guaranteeing complete and faithful performance of all obligations and conditions placed on Contractor by contract.

PLANNING COMMISSION – Empowered to review and take action on land-use applications; decisions are usually binding but may be appealed to City Council. Makes recommendations to City Council regarding City's comprehensive plan, facilities plan, and planning and zoning ordinances.

PLANS – Construction plans, including system plans, horizontal plans, and profiles, cross sections, detailed drawings, etc., or reproductions thereof, approved or to be approved by the Public Works Director, which shows the location, character, dimensions, and details for the work to be done, in which constitute a supplement to these standards.

POTABLE WATER – Water which is satisfactory for drinking, culinary, and domestic purposes and meets the requirements of the health authority having jurisdiction.

PREDEVELOPED – Considered as the natural, unimproved and unaltered state of the land.

PRIVATE COLLECTION SYSTEM – A privately owned and maintained sewer system installed to serve multi-unit structures on single ownership properties, which cannot legally be further divided.

PRIVATE STORM DRAIN – Any storm sewer located on private property serving more than one structure on the same premises or parking lot catch basins.

PRODUCT DATA – Complete catalog data for manufactured items of equipment and all component parts, including specific performance data, material description and source, rating, capacity, working pressure, material gauge thickness, brand name, catalog numbers, and other necessary information.

PROJECT CORRECTION LIST – Final project inspection to repair checklist, or punch list, compiled after construction of total project is complete, and after all testing is satisfactorily finished.

PROPOSAL – Offer for work made out and submitted on prescribed proposal form and properly signed and guaranteed by bidder.

PUBLIC ROAD – Road dedicated for use by public and maintained by the public.

PUBLIC SANITARY SEWER – Any sewer located in a public right-of-way or easement and operated and maintained by the City for carrying sewage and industrial wastes.

PUBLIC STORM DRAIN – Any storm sewer located in a public right-of-way or easement and operated and maintained by the City.

PUBLIC WORKS DIRECTOR, CITY ENGINEER – Professional Engineer registered in the State of Oregon, designated by the City Manager to carry through with planning, designing, and project supervision of public facilities that will be accepted and owned by the City. Person designated to have the authority to review and approve all public works design and construction project.

PUBLIC WORKS FACILITY – Any facility constructed in public right-of-way or public easement that is either immediately or eventually to be taken over by City for maintenance and operation; includes but is not limited to streets, sidewalks, curbs, parking lots, driveways, drainage facilities, water system works, and sanitary sewer systems.

PUNCH LIST – See Project Correction List.

RECORD DRAWINGS – Plans signed and dated by the project Engineer indicating that the plans have been reviewed and revised, if necessary, to accurately show all as-constructed details and changes.

RELEASE RATE – The controlled rate of release of drainage, storm, and runoff water from property, storage pond, runoff detention pond, or other facility during and following a storm event.

REPRESENTATIVE – Public Works Director or authorized representative.

RESERVE STRIP – A 1-foot-wide section adjacent to or at terminus of right-of-way, to be recorded as a plat restriction with access controlled by the Public Works Director.

RIGHT OF WAY – All land or interest therein which by deed, conveyance, agreement, easement, dedication, usage, or process of law is reserved for or dedicated to the use of the public for sidewalk, utility, and or roadway purposes.

ROADWAY – All of that portion of the right-of-way used or to be used for vehicle movement which exists between the curbs or proposed curb lines.

SEDIMENTATION – Disposition of erosional debris, soil sediment transported by water from a higher elevation to an area of lower gradient where the sediments are deposited as a result of slack water.

SENSITIVE AREA – Areas sensitive to environmental degradation, such as existing or created wetlands; rivers, streams, and springs with year-round or intermittent flow; and impoundments (natural lakes and ponds). Sensitive areas also include any locally designated Goal 5 resource.

SEWER MAIN – A public sewer that has been or is being constructed to accommodate more than one sewer lateral or to which a building sewer connects or may connect (Normally not less than eight inches in diameter)

SEWAGE – A combination of water-carried wastes from residences, business buildings, institutions, and industrial establishments, except industrial wastes.

SHOP DRAWINGS – Diagrams, drawings, illustrations, brochures, schedules, and all other data submittals required by Contractor and furnished by Contractor illustrating fabrication, installation, dimensions, and other aspects of work.

SIDWALK – A walk or path along the side of a road for pedestrians. A right-of-way deeded, dedicated, and designated for the use of non-motorized vehicles and pedestrians.

SILT – Fine textured soil particles including clay and sand as differentiated from coarse particles of sand and gravel.

SILTATION – Deposition of (silt) waterborne sediments.

SPECIFICATIONS – Directions, requirements, explanations, terms, and provisions in these standards, supplemented by such special conditions as may be necessary pertaining to various features of work to be done, manner and method of performance, and manner and method of measurement and payment; specifications include directions, requirements, and explanations that appear in plans.

STANDARD DRAWINGS – The drawings of structures or devices commonly used on public improvements and referred to on construction plans.

STANDARD SPECIFICATIONS – Codes, rules, and regulations set forth in City of Molalla "Standard Specifications for Public Works Construction".

STANDARDS – Specifications in the "Standard Specifications for Public Works Construction" adopted for use in City of Molalla.

STEEL PLATE – A-36 steel meeting AASHTO H-20 loading specifications.

STREETS AND ROADS – Any public highway, road, street, avenue, alleyway, easement or right-of-way used or to be used for vehicle movement.

STRUCTURES – Those structures designated on the standard plans such as catch basins, manholes, etc.

SUBCONTRACTOR – Any individual, firm, or corporation having contract with a general contractor or with any other subcontractor for performance of part of work.

SUBDIVISION – To divide an area or tract of land into four or more lots within a calendar year when such area or tract of land existed as a unit or contiguous units of land under a single ownership at the beginning of such year.

SUBSTANTIAL COMPLETION – When the Public Works Department authorized representative determines that all of the requirements are met for the construction, testing, and approval of the following: public water systems, public sewer system, public storm systems, private storm water quality/quantity systems, public roadway paving, public roadway striping and signage, public roadway lighting activation, ADA facilities, conditioned offsite improvements, pedestrian and bicycle improvements, transit improvements, park improvements, recording of all public easements, right-of-way dedications, plats, partitions, and park related land dedications, and all fire, life, and safety issues meet code.

SUBSTANTIAL PROGRESS – In the opinion of the City's authorized representative, construction work is proceeding at a rate close to that of the submitted construction timetable.

SUPER ELEVATION – The vertical distance between the heights of the inner and outer edges of a highway pavement.

TRANSVERSE JOINT – A joint which follows a course approximately perpendicular to the centerline of the roadway.

TRAVELED WAY – That portion of the roadway for the movement of vehicles, exclusive of shoulder and auxiliary lanes.

TURNAROUND AREA – An area of sufficient size and configuration that a motor vehicle may maneuver so as to travel in the opposite direction.

TRUNK SEWER – (Interceptor) A sanitary sewer which is primarily intended to receive waste water from a collector sewer, another trunk sewer, an existing major discharger of raw or inadequately treated wastewater, or water pollution control facility.

UNIFORM PLUMBING CODE – The Uniform Plumbing Code adopted by the current edition of the International Association of Plumbing and Mechanical Officials, as revised by the State of Oregon, called the "Oregon State Plumbing Specialty Code".

WASTE WATER – The total fluid flow in the sanitary sewerage system which includes industrial waste sewage, or any other waste including that which may be combined with any ground water, surface water, or storm water that may be discharged into the sanitary sewerage system.

WATER DISTRIBUTION SYSTEM – Water distribution pipelines, pumping stations, valves, and ancillary equipment used to transmit water from the supply source to the service line.

WATER MAIN – The water-supply pipes for public or community use.

WATER SERVICE LINE – The pipe connection from the City water main to the users' water meter, hydrant, back flow prevention device, or fire sprinkler double check valve.

WETLANDS – Those lands adjacent to watercourses or isolated therefrom which may normally or periodically be inundated by the waters from the watercourse or the drainage waters from the drainage basin in which it is located. These include swamps, bogs, sinks, marshes and lakes, all of which are considered to be part of the watercourse and drainage system of the City and shall include the headwater areas where the watercourse first surfaces. They may be, but are not necessarily, characterized by special vegetation or soils such as peat, muck, and mud.

WET-SEASON – For the purpose of monitoring ground water elevations, the "wet-season" is defined as November 1 through April 30.

WORK – Furnishing of all labor, materials, equipment, and other incidentals necessary or convenient to successfully complete project or part of project and carrying out of all duties and obligations imposed by contract.

WRITTEN NOTICE – Written communication delivered in person to individual or to member of firm or to officer of corporation for whom it is intended. If delivered or sent by mail to last business address known to one who gave notice, it shall be duty of each party to advise other parties to contract of any change in business address until contract is complete.

1.14 CONTROL OF PUBLIC WORKS PROJECTS

a. All public system improvements and public works facilities, or improvements or facilities to become public, shall be designed by a Professional Engineer registered in the State of Oregon. All public system improvements and public works facilities shall be designed and constructed in accordance with all applicable rules and regulations of the City and any City interpretations of those rules and regulations, including applicable technical guidance manuals, and in accordance with all applicable federal, state, and local statutes and rules.
b. Approval of the plans must be made by the City's authorized representative before construction is permitted. An authorized representative of the City will be available for construction observation during construction of the project.
c. At the completion of construction, the design engineer shall submit a completion certificate to the City stating that all work has been completed in accordance with the approved project plans and specifications, or approved modifications to the plans.
d. All surveys for public works facilities shall be performed under the direction of a Professional Land Surveyor registered in the State of Oregon. All elevations on design plans and record drawings shall be based on NAVD 88 Datum. A list of acceptable benchmarks is available at the Clackamas County Surveyor's Office
e. Materials and workmanship shall meet or exceed the adopted standards and at all times shall be subject to the approval of the City's authorized representative.
f. On completion of projects to become public works, the Applicant or their Design Engineer shall submit one complete set of reproducible record drawings in accordance with Subsection 1.17.17, "Project Closeout" to the City's authorized representative for future reference. The drawings shall show any deviations from the original construction drawings and shall include sufficient information to accurately locate water, sanitary sewer, and storm sewer service extensions. No bond will be released until the City's authorized representative receives an acceptable set of reproducible record drawings from the design engineer, with his or her stamp of certification.

Before the City accepts a public works project for operation and maintenance, a one-year guarantee on all materials and workmanship incorporated in the project shall be provided to the City on one of the acceptable forms described in Subsection 1.17.18, "Maintenance Assurance and Warranty".

1.15 DEVELOPMENT PROCESS REQUIREMENTS

1.15.1 Pre-Application Conference

The City of Molalla will hold a pre-application conference with the Applicant (owner/developer), unless otherwise waived by the Public Works Director, before formal application for public works permits and review of site design and construction plans. The pre-application process allows the applicant and the City to discuss the proposed project and the standards and regulations that will apply while the project is still in a preliminary stage. Any specific development standards, regulations, or problem areas can be discussed before the applicant makes a substantial investment in the project or proceeds with a formal application unaware of the issues.

1.15.2 Plan Check and Permits

a. **Plan Check:** Design reviews are required, and review approvals issued on all construction projects within public right-of-way, easements, or property which will eventually be maintained and operated by the City of Molalla. Projects that require plan checks include all private storm drainage, sanitary sewer, and water systems that will be connected to or that will discharge into a system under the jurisdictional control of the City of Molalla.
b. **Public Works Permit**: No work shall be performed, nor materials stored, nor encroachment made on or within a Right-of-Way, Public Easement, or Public Utility Easement without first acquiring a permit from the City's Public Works Department, except as provided by City Ordinance. Projects requiring Public Works Permits shall include, but not necessarily be limited to, improvements or upgrades to publicly owned and maintained streets, sidewalks, curbs, driveway approaches, water systems, sanitary sewer systems, and storm drainage systems. Any permits required by federal, state, and local governments shall be obtained by the person proposing the improvements.
c. **Utility Construction Permit**: The construction, repair, maintenance, or replacement of all other utilities located within a public right-of-way or public easement, including but not limited to, power, telephone, gas, and cable television shall be required to submit for plan check and obtain a Utility Construction Permit.
d. **Right of Way Permit**: For all other work done within the Right-of-Way that blocks, partially blocks, hinders or impedes the flow of traffic, cyclists, or pedestrians, a Right of Way Permit shall be required.

1.15.3 Plan Check Requirements

A copy of the Public Works Department design requirements**,** which is available for download from the City website, will be used as a guide during the review of all proposed new, or improvements to, public works facilities. The following requirements shall be met before the City's authorized representative completes a plan check:

a. Satisfy all requirements of the Molalla Municipal Code and other ordinances and regulations pertaining to construction in the City of Molalla.
b. Submit a completed Public Works Construction Permit and engineer's estimate.
c. Submit four copies of stamped and signed detailed plans and specifications produced by a Professional Engineer registered in the State of Oregon. Incorporated within the construction plans and specifications shall be applicable franchise utility installation plans, stamped and signed and prepared by the proper authority. Copies will be routed for review to other divisions within the City and the Molalla Fire District for a comprehensive plan review.
d. For projects which include street construction, re-construction or expansion, submit one set of the Geotechnical Report in conformance with Subsection 2.2.1, "Subgrade Evaluation"

and one set of the stamped and signed street design calculations in conformance with Subsection 2.2, “Street Design”.

e. Submit one set each of a stamped and signed storm water design report in conformance with Subsection 3.3.1, “Hydrologic Analysis”.
f. Submit one set each of stamped and signed design calculations for the water system design, wastewater system design, or storm drainage system design where applicable or as required.
g. Submit one set of stamped and signed soil-bearing tests, as required by the City for pavement design, to verify street section designs and alternatives. Soil testing to ascertain the strength of the soil is required for all roads to analyze and design the road structural section. Soil tests are needed on samples of the subgrade material that is expected to be within 3 feet of the planned subgrade elevation. Samples are needed for each 1,000 feet of roadway and for each visually observed soil type. Soil tests are required for a minimum of two locations.
h. A plan check fee must be paid before a plan review will be started. The amount of the fee will be established by resolution of the City Council.
i. Plans deemed incomplete by the City’s authorized representative may be returned without a full plan review being completed. An explanation will be provided by the City indicating sections of the plans deemed incomplete. Once all items are addressed, plans may be resubmitted for review.
j. Plans shall include all necessary current City details and City Construction Note Sheet.

1.15.4 Plan Sheet Requirements

Sheet Size

All construction plans shall be clearly and legibly drawn on bond sheets measuring 22 x 34-inches. Sheets shall have 1-1/2 inches of clear margin on the left edge and a 1/2-inch margin on all other edges.

Sets of Plans

When plans are prepared for developer financed projects, the following scale of drawings is suggested.

Plan/Scale	Horizontal	Vertical
Street*	1" = 20''	1" = 2'
Sewer	1" = 20 or 40'	1" = 4'
Storm	1" = 20 or 40'	1" = 4'
Water**	1" = 20' or 40'	1" = 4'

*Subdivision street plans, when combined with other proposed facilities listed above, may be drawn at 1" = 40' scale.

**When a scale is used which is smaller than 1" = 20' (i.e., 1" = 40') intersection details showing fittings and valving shall be provided at a larger scale.

Architectural scales (i.e., 1/4" = 1'-0") are not permitted.

Required Sheets

Construction plan submittals shall contain the following minimum sheets: title sheet (unless not required by the Public Works Director), general notes and legend sheet, composite utility sheet, plan and profile sheets, detail sheets.

Title Sheet

All subdivision projects and multiple street improvement projects shall have a title sheet as the first page of the construction plans. This sheet shall contain the following minimum information.

a. Site plans of the entire project with street right-of-way and/or subdivision layout at a 1" = 100' scale. A 1" = 200' scale may be used if project size is too large. The site plan shall also include all adjacent public facilities within 100' of the proposed project.
b. Vicinity map at a 1" = 1000' scale, or greater.
c. Index of sheets.
d. Complete legend of symbols used.
e. Temporary and/or permanent bench marks used along with their descriptions, elevations of benchmark and datum.
f. Engineer's name, address and phone number & seal.
g. Surveyor's name, address and phone number.
h. Developers/owner's name, address and phone number for public improvements with private financing.
i. Provide contact phone number for all affected utility companies (PGE, NW Natural Gas, Molalla Communications, and Wave Broadband).
j. Show tax lot numbers for subdivision parcels and addresses of existing properties.

General Notes & Legend Sheet

The general notes and sheet shall contain the standard City notes and any other construction notes pertinent to project. A legend for existing and proposed facilities shall be present and proposed facilities shall be bold.

Composite Utility Sheet

The composite utility sheet shall show all properties served by proposed sewer, water and storm facilities, in addition to the proposed facility and all easements. This plan sheet shall be used to identify and analyze the extension of the proposed facilities. The topographic plan shall show all upstream and tributary areas within no less than 200 feet of the proposed development. The plan shall include existing contours at one (1) foot intervals, or as approved by the City. Include location of existing structures and public and private utilities.

Plan Sheet

The plan view of each sheet shall be drawn at the appropriate scale showing the following minimum information:

a. Adjacent Street curbs, property lines, right-of-way lines, utility easements referenced to property lines, street centerlines and intersections. Show property corner and curb elevations to determine water service level, serviceability of lot/property and sanitary sewer, points of disposal for building storm drains, and how new curbs will join to existing curbs.
b. Location of all underground utilities within 100 ft. of the project (if they are affected by the project), existing power/telephone poles and guy anchors, valves, manholes, catch basins, fire hydrants, meter boxes and vaults, signs, etc.
c. Location of all water courses, railroad crossings, culverts, bridges, large water transmission pipes and gravity sewers and/or storm drains within 200 feet of proposed gravity sewer and storm drain extensions if they affect the design of the project. All water courses shall show the 100-year flood plain as indicated on the U S. Army Corps of Engineers and Federal Emergency Management Agency (F.E.M.A.) maps.
d. On sewer and storm drain plans, each manhole, catch basin, and clean-out shall be numbered and stationed. Stationing shall tie to existing street monuments, property corners or manholes. Each line shall be stationed continuously upgrade and go from left to right on the plan sheet. Each separate line shall be separately designated (e.g., sewer line 'A', storm line 'A', etc.). Existing manholes and catch basins shall be labeled with the City numbering system.

e. On street plans, horizontal stationing shall show points of tangent and curvature for centerline curve data shall show tangent length, radius distance, centerline curve length, and delta angle. Centerline intersection stationing, in both directions, shall be shown.
f. Where streets are being widened, edge of pavement elevations shall be shown to determine pavement cross-slope to new curb or pavement edge.
g. On water plans, all fittings shall be shown and identified by type (i.e., MJ x MJ, FLG X MJ, etc.). Fire hydrants and intersection details for valves and fittings are required when scale of plans is smaller than 1" = 20' (i.e., 1" - 40'). All valves, fittings and pipe conditions shall be indicated.
h. On erosion control plans, the location of silt fences, inlet barriers, gravel entry ways, temporary ditches and detention ponds and surface preparation shall be shown. The plan shall show the entire development. Details of erosion control devices can be shown on this sheet.

Profile Sheet

Profiles for construction plans shall be the same horizontal scale as the plan sheet. Where profiles are drawn on the same sheet as the plan view, the profile shall be immediately below the plan view. Stationing shall be continuously upgrade from left to right with lower stations to the left. The following minimum information shall be shown:

a. For sewers and storm drains, show locations of manholes, catch basins, and clean outs with each numbered and stationed. Existing manholes and catch basins shall be labeled with the City numbering system.
b. Existing profile at centerline of proposed utility or street.
c. Proposed profile grade, as appropriate, for all sewers, storm drams and water lines giving pipe size, length between structures, slope, backfill type, surface restoration type, and pipe materials, sewer inverts and direction, rim elevations, etc.
d. Existing and proposed underground utility that crosses the alignment of the proposed facility.
e. Beginning of all vertical curves, points of vertical intersection, end of vertical curve, low/high point of sag/crest curve and length of vertical curve. Profiles of existing centerline grade shall extend a minimum of 250 feet beyond the end of the improvement.
f. Clearly show all potential utility conflicts with appropriate pipes, conduits, vaults, etc. that affect proposed design.

SPECIAL NOTE: The City of Molalla record drawings are only to be used as an aid to the engineer. When a potential conflict may occur, the engineer shall field locate, or cause to be located, and verify the alignment, depth, and inverts of all existing facilities shown on the plans that will be crossed by the proposed facility.

Detail Sheets

Detailed drawings shall be included with all construction plans where City of Molalla Standard drawings do not exist. If a standard drawing must be modified to fit existing or unique conditions, the modified drawing shall be shown on the plans. When appropriate, due to required detail complexity, a separate detail sheet shall be drawn. When City standard drawing appurtenances or construction installations are to be used, a reference to the specific Standard Drawing number shall be made on the title sheet.

Supporting Information

The engineer shall submit sufficient supporting information to justify the proposed design. Such information shall include, but not be limited to, the following:

a. Design calculations.
b. Hydrology and hydraulic calculations with basin maps.
c. Alternate materials specifications including manufacturers' design application recommendations.

d. Plan support information to include as appropriate: Soils engineering report, Hydrology report, and Engineering geology report.

Plan Submittal

Construction plans for all privately financed public works facility improvements shall be submitted to the City. The Public Works Director will coordinate the plan review and approval of all construction plans which will include review for compliance with all Molalla Design Standards, utility master plans, City Code and Ordinances.

All plan submittals shall include information required in below along with all other information requested by the Public Works Director. This information shall include, but is not limited to, construction cost estimates, easement documents, right-of-way dedications, and executed agreements. All submittals will be reviewed for completeness and the engineer notified if required information is missing. Submittals should be made in a timely manner as lack of information to the City may impede the review process.

Street

The following minimum information shall be noted on the street record drawings:

a. Change in horizontal alignment, curve data and stationing of primary control points (e.g., PC, PI, PT, and PRC).
b. Vertical curve or grade changes; change in location of low point in sag vertical curve.
c. Change to approved thickness for street structural section components. Show station limits where changes in structural section have occurred.
d. Change to driveway locations or widths.
e. Other change(s) altering the approved plans, including but not limited to; curbs, sidewalks, wheelchair ramps and lighting.

Storm Drains

The following minimum information shall be noted on storm drain record drawings:

a. Station of wye or tee into main line. Tie each end of branch line to nearest property corner a right-of-way line, and distance back from the face of curb.
b. Show alignment changes, grade changes and changes in construction materials. If changed alignment results in station changes, a station equation shall be shown as appropriate at a manhole.
c. Other change(s) altering the approved plans, including but not limited to; catch basin location, manhole location, pipe size, dry well location, etc.

Sanitary Sewer

The following minimum information shall be noted on sanitary sewer record drawings:

a. Station of wye or tee into main line. Tie each end of service lateral to nearest property comer at right-of-way Line, and distance back from the face of curb.
b. Depth at the end of service lateral measured from existing ground to invert of pipe. When required by the Public Works Director, invert elevations shall be noted.
c. Length of service lateral measured from centerline of sewer main to end of pipe.
d. Show alignment changes, grade changes, pipe size changes and changes in construction materials. If changed alignment results in station changes, a station equation shall be shown as appropriate at a manhole.
e. Other change altering the approved plans.
f. Provide complete test results to the Public Works Director.
g. Type of pipe, backfill material and location.

Water Main

The following minimum information shall be noted on water main record drawings:

a. Station and/or property line/comer to valves (not at standard location), all fittings, blow-offs and dead-ended lines.

b. All changes from standard 30-inch depth cover. Limits shall be shown on all plans with annotated reason for change. Actual pipe elevation (top of pipe) will be taken at each fitting.
c. Show alignment changes, grade changes, pipe size changes and changes in construction materials, if changed alignment results in station changes. A station equation shall be shown as appropriate at a valve.
d. Provide manufacturer of all valves; identify types of fittings (i.e., MJ X MJ, FLG x MJ, etc.); provide information in the form of an inventory list on construction drawings.
e. Other change altering the approved plans.
f. Provide complete test results to the Public Works Director.
g. Provide photographs of all installed valves, thrust blocks, and fittings in place before backfill.

1.15.5 Plan Review

a. If all conditions of the plan check requirements as specified in Subsection 1.15.3, "Plan Check Requirements," are met, and no additional information is requested by the City's authorized representative, a plan review will be completed. The City's authorized representative will prepare a plan review redline comments list, to be sent to the appropriate permit applicant or responsible party. The list will indicate any deficiencies in the construction plans and specifications. The proper party shall then make the corrections and resubmit the plans and specifications.
b. Once the plans and specifications are approved for construction, the City's authorized representative shall issue a written notice of plan approval. The written notice of plan approval shall remain in effect for 90 calendar days from the date of approval. If the applicant cannot proceed with the project within the 90-day limit, a 90-calendar-day extension can be applied for by submitting a written request to the Public Works Director. If no substantial progress has been made within the allotted time, no further plan approval extension will be granted, the plan review fee shall be forfeited to the City, and the plan approval will expire. Plans may be resubmitted, subject to payment of new plan review fees.

1.15.6 Record Drawings, Maps, and Plans Not Guaranteed

Record drawings, maps and plans are provided to the City by the Owner/Developer upon completion of development and/or improvement projects within the City. The City does not guarantee the accuracy of measurements, elevations, locations, or other information on such maps and plans. All information shall be independently verified by a registered engineer, as part of their due diligence, via survey, core drill and vacuum excavation (permit and inspection of repairs required), or other appropriate means prior to conducting any improvement or development.

1.15.7 Permit and Assurances

a. Before any public construction begins, a performance bond, irrevocable stand-by letter of credit, or cash deposit in form and substance satisfactory to the City Attorney and City Finance Director and meeting the requirements in Subsection 1.15.9, "Qualifications of Insurance and Bonding Companies" shall be submitted by the applicant as a performance assurance for such construction. The bonding is required for all work in existing public right of way. Bonding is also required for public improvements on private property as a condition of the final plat review and approval process. The amount of the performance assurance for private development projects shall be 125% of the design engineer's estimate or written estimates by three contractors with their names and addresses, on public improvements and shall be conditional on the performance of all terms and conditions of the permit and these standards. The guarantee shall include, but not be limited to, restoration of settled fills, trenches, pavement, and surfaces. The amount of the performance assurance for public projects administered by the City shall be 100% of the full contract price in accordance with

ORS 279C.380. Additionally, a payment bond in the amount of 100% of the full contract price shall be submitted in accordance with ORS 279C.380 unless exempted by the Local Contract Review Board in accordance with ORS 279C.390.

b. When all requirements stipulated here are met and the construction plans are stamped and signed by the City's authorized representative, a Public Works Permit can be issued on payment of the Public Works Permit fee. The amount of the fee will be established by resolution of the City Council.

c. The Public Works Permit shall be valid for one year from the date of issuance. If time elapses on the permit, the applicant can request in writing a permit extension from the Public Works Director or the City's authorized representative. If the request is approved, the permit holder then has 180 calendar days to begin construction on permitted projects and shall show substantial progress during this permit extension, as determined by the City. If no substantial progress is made within the allotted time, no further permit extension will be granted, the permit will expire, and the permit fees will be forfeited to the City. Plans may be resubmitted, subject to payment of new fees. Resubmitted plans shall be reviewed to determine compliance with the Public Works Standards, including any newly approved codes and/or regulations. Payment of a public works permit fee for construction will be required before a permit for construction is issued.

1.15.8 Insurance Requirements

The City requires additional assurances from the applicant/contractor including, but not limited to, Certificates of Insurance, naming the City as an additional insured, from insurance companies or entities acceptable to the City and meeting the requirements in Subsection 1.15.9, "Qualifications of Insurance and Bonding Companies." The Certificate shall specify all of the parties who are Additional Insureds. The contractor shall be responsible for paying all deductibles, self-insured retentions and/or self-insurance included under these provisions. For City administered projects, a Certificate of Insurance shall be executed by the successful bidder and their insurance company prior to the execution of the contract by the applicant.

Primary Coverage - Insurance carried by the Contractor shall be the primary coverage and the City's insurance is excess and solely for damages or losses for which the City is responsible.

Comprehensive or Commercial General Liability - Contractor shall obtain at the Contractor's expense and maintain comprehensive of commercial general liability insurance covering bodily injury and property damage. This insurance shall include personal injury coverage, contractual liability coverage for the indemnity provided for under this contract, and products/completed operations liability. The coverage for personal injury for one claimant shall not be less than $1,000,000 and $2,000,000 from one occurrence. The coverage for property damage shall not be less than $500,000 for one occurrence.

1.15.9 Qualifications of Insurance and Bonding Companies

a. **Minimum requirements:** All bonding and insurance companies providing insurance or bonds required by the City must meet certain minimum financial security requirements. These requirements conform to the rating published by A.M. Best & Co. and a current Bests Key Rating Guide-Property-Casualty. All companies providing bonds or insurance must meet the following requirements.

- Have a current Bests Rating not less than A-.
- Have a current Bests Financial Size Category not less than Class IX.
- Be authorized to conduct and transact insurance and surety contracts in the State of Oregon.

- Be a U.S. Treasury Circular 570 listed company, if providing payment or performance bonds.

Failure to meet minimum requirements: If the issuing company does not meet these minimal requirements, or for any other reason is unsatisfactory to the City, written notification will be made by the City to the Applicant, who must promptly obtain and submit to the City a new policy or bond issued by an insurer/surety acceptable to the City.

1.15.10 Indemnification

The applicant/contractor shall indemnify and hold harmless the City of Molalla and its officers, agents, and employees; Molalla City Council; City of Molalla Urban Renewal Agency and its officers, agents, and employees; and Molalla Urban Renewal Board from and against all claims, demands, penalties, damages, losses, expenses, including attorney's fees, and causes of action of any kind or character, including the cost of defense thereof, arising or alleged to have risen in favor of any person on account of personal injury, death, or damage to property arising out of or resulting from, or alleged to have risen out of or resulted from, in whole or in part, any act or omission of the applicant, the applicant's design engineer, the applicant's contractor, or anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable.

1.16 CONSTRUCTION PROCEDURAL REQUIREMENTS

1.16.1 General Procedure and Requirements

a. During the construction period, the City will maintain two sets of approved plans and specifications. The permit holder or contractor shall retain one set of approved, stamped, and signed plans and specifications at the construction site at all times. Any modification to the approved plans shall be first approved, stamped, and signed by the City's authorized representative prior to construction of the modification.
b. A pre-construction conference with the City's authorized representative and the applicant, contractor, design engineer, and other parties requested to attend or having an interest in the project will meet to discuss the project before any construction begins. The pre-construction conference will discuss the role of the City's inspection team and the team's relation to the contractor and applicant.
c. An inspection criteria checklist may be provided to the contractor outlining necessary inspections, if requested. The customary inspections are generally as follows:
    1. All underground utilities, including water, sanitary sewers, and storm sewers.
    2. All subgrade preparation, fill placement, base rock, and leveling rock.
    3. All concrete pours, such as driveways, sidewalks, curbs, catch basins, manholes, and cleanouts.
    4. Asphaltic or Portland cement concrete pavement.
d. The City's authorized representative shall at all times have access to the project and will make routine inspections. Should any inspection reveal that the construction of the improvements is not proceeding according to the approved plans and the specifications in this document, the Public Works Director may order all work stopped, all defective work removed, or both.
e. The contractor shall give the City's authorized representative a minimum of 24 hours' (one working day) advance notice before a required inspection. It is the responsibility of the permit holder or contractor to obtain inspections and approvals for all work installed.
f. Failure to give advance notice to the City's authorized representative for inspections, receive adequate inspections, or violation of other regulations, ordinances, resolutions, rules, and City codes as outlined in these standards can result in one or more of the following, as determined by the City:

1. Stoppage of work until problem is resolved.
2. Suspension of future inspections.
3. Withholding certification of projects as complete, which is required to begin warranty period and eventual City acceptance for maintenance and operation.
4. Citation for violation of the Molalla Code and its penalties and provisions.
5. Uncovering or removal of work not inspected.

1.16.2 Testing of Construction Work

a. The applicant shall be responsible for providing the name of a compaction-testing firm that will be paid by the permit applicant and that will supply the City's authorized representative with the compaction tests needed to certify that the soils, aggregate, and surface materials meet the minimum requirements of these standards. The testing firm hired by the permit applicant shall be required to be under the direct supervision of a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering.
b. The applicant shall also be responsible for providing the name of a materials-testing firm that will be paid by the permit applicant and that will supply the City's authorized representative with the concrete-strength tests and other materials tests required to certify that the materials meet the minimum requirements of these standards. The testing firm hired by the permit applicant shall be required to be under the direct supervision of a Professional Engineer registered in the State of Oregon.
c. City reserves the right to direct testing firm on frequency of testing.

1.16.3 Right of Entry to Work

Representatives of the City and any federal, state, or local agencies having jurisdiction over the work shall have right of entry to any and all parts of the work at reasonable times. The contractor shall cooperate in all respects with such agencies and shall provide proper facilities for access and inspection.

1.16.4 Suspension of Work

The Public Works Director may suspend the work and give written notice to the applicant/contractor of such suspension when the contractor is using material that does not conform to the requirements of the contract documents or when the contractor is improperly performing the work, and neglects or refuses to replace or reconstruct such work. The suspension shall remain in effect until appropriate corrections are made. Review of the Public Works Director's decision shall be made, on written request, by the City Manager within 48 hours of the initial suspension. Regardless of the decision, the City shall not incur pecuniary liability for an incorrect suspension of work, unless such suspension was a willfully malicious act of the City.

1.16.5 Protection of Existing Facilities

a. The approximate location of underground City water, sewer, and storm drainage facilities are available at the Public Works Director's office. The approximate locations of underground power, gas, telephone, and cable facilities are available from the serving utility companies. The location of existing facilities shall be shown on the construction drawings for public works projects.
b. Appropriate and timely notice shall be given to all public and private utility companies in advance of construction, for the purpose of protecting or relocating existing facilities. The exact location of underground facilities shall be verified in advance of public works construction, in cooperation with the public or private utilities involved.

c. When the contractor is physically locating underground utilities in roadways, the Portland cement concrete (PCC) or asphalt concrete (AC) roadway surfaces shall be cored and not square-cut.
d. All existing underground and surface facilities shall be protected from damage or degradation during construction of public works facilities.
e. Any existing facilities not specifically designated for alteration or removal that are damaged or degraded during construction shall be restored or replaced to an "in kind" or better condition at the contractor's expense.
f. Turf damaged during utility construction shall be replaced with sod in a timely manner acceptable to the City's authorized representative.

1.16.6 Surveying and Land Monuments

a. **NAVD 88 Datum**: All elevations on design plans and record drawings shall be based on NAVD 88 Datum. Each page of the plans and drawings shall state the benchmark datum information. Note that City of Molalla control points are based on NGVD 29 datum and that necessary adjustments will need to be made by the applicant's surveyor to meet NAVD 88 requirements.
b. **Permanent Survey Markers:** Before beginning any construction activity, the applicant's engineer/surveyor shall adequately reference all permanent survey monuments, property corners, stakes, or benchmarks on the subject site, or markers that may be subject to disturbance in the construction area or during the construction of any off-site improvements. It shall be the responsibility of the contractor to protect survey monuments throughout the construction process. The contractor shall not disturb permanent survey monuments without written consent from the City's authorized representative.
c. **Disturbed, Destroyed, or Lost Monuments:** If any survey monument is disturbed, moved, relocated, or destroyed as a result of construction activity, the contractor shall, at contractor's cost, retain the services of a Professional Land Surveyor registered in the State of Oregon to restore the monument to its original condition and shall file all documentation required by Oregon law. A copy of the recorded documentation shall be submitted to the Public Works Director.

1.16.7 Railroad Crossings

a. Crossings of railroad rights-of-way shall be done in a manner that conforms to the requirements of ODOT Rail Division and the railroad having jurisdiction. If any bonds or certificates of insurance protection are required, they shall be furnished by the contractor or applicant to the railroad company concerned, with the City as an additionally named insured. Costs for railroad flagging shall the responsibility of the applicant
b. Permits or easements for such crossings shall be obtained by the applicant. All the terms of such permits or easement shall be met by the applicant and contractor. In some locations, the railroad may require casing pipe.

1.16.8 Criteria for Stream-Road Crossings

a. Stream crossings shall be avoided whenever possible, whether by roads, utilities, or other development. If streams must be crossed, impacts shall be minimized by preferring bridges to culverts, and by designing bridges and culverts to pass at least the 100-year flood and meet the Oregon Department of Fish and Wildlife (ODFW) Fish Passage Criteria, or latest edition.
b. Before any work may be performed in any stream, the method of operation and the schedule of such work shall be approved in writing by the City's authorized representative. The timing of in-water work shall comply with the guidelines established by the ODFW.

Mechanized equipment shall enter streams only when necessary and only within the immediate work area.

c. The contractor shall comply with the regulatory requirements of the Oregon Department of State Lands, ODFW, U.S. Fish and Wildlife Department, U.S. Army Corps of Engineers, National Marine Fisheries Service, and any other state and federal agencies having jurisdiction.

1.17 CONSTRUCTION

1.17.1 Construction Commencement

a. The contractor shall not undertake nor instruct the subcontractor(s) to undertake any portion of the work without notifying the City's authorized representative 24 hours in advance of beginning work. At the time of this notice to the City, the applicant shall have submitted to the City a performance assurance, construction permit agreement, appropriate plan check and permit fee, certificate of insurance, any necessary off-site easements, and have been issued a public works permit.

b. Contractor shall conduct construction activities only during the hours of work guidelines established by the City.

1.17.2 Scheduling

a. **Sequence of Operations:** The contractor shall plan construction work and execute operations with a minimum of interference to the operation of existing City facilities and the traveling public. It may be necessary to do certain parts of the construction work outside normal working hours to avoid undesirable conditions, and it shall be the obligation of the contractor to make this change to the work schedule. Such scheduling, however, is subject to approval of the City's authorized representative, and does not relieve the contractor from making their work available for inspection.

b. **Progress of Construction:** Construction shall proceed in a systematic manner that will result in minimum inconvenience to the public. Contractor shall pothole and verify existing utilities and facilities prior to commencing proposed work. Erosion control measures shall be installed and inspected per, Subsection 1.17.3, "City Inspections" prior to commencing work. Construction staking for the work being performed shall be completed before the start of excavation. The contractor shall limit their operations to a small work area per crew. At no time shall the trenching equipment be farther than 100 feet ahead of the pipe-laying crews, unless advance written permission is given by the City's authorized representative. The trench shall be backfilled in conformance with Section 8, "Trench Excavation and Backfill Standards," so that no section of trench is left open longer than 24 hours. Before the contractor stops construction for the day, trenches located in the right-of-way shall be completely backfilled, unless the trench is covered with secured Steel Plates.

c. **Steel Plates:** Where Steel Plates are used as a temporary road surface they shall comply with the following:
   - Steel Plates shall be A-36 steel meeting AASHTO H-20 loading specifications.
   - Steel Plates shall be centered over the cut. No more than ½ of the plate shall span a trench that has been completely backfilled, or no more that ⅓ of the plate shall span a trench that has not been completely backfilled.
   - Uneven pavement surfaces must first be leveled with cold mix before laying plates over trench.
   - Plates shall be secured to the roadway with a minimum of two ½-inch or larger steel pins driven a minimum of 6 inches below the surface and at least 18 inches from the edge of the road cut.

- Cold patch shall be used to ramp up to the Steel Plate edges; minimum 6-inch ramp per ½-inch difference in grade change between road surface and Steel Plate.
- Contractor is responsible for maintaining cold mix around Steel Plates.
- Use of plates in travel lanes shall require contractor to place a 30-inch by 30-inch "STEEL PLATE AHEAD" warning sign for each affected travel direction.
- Plates shall not be left in the travel lane for longer than 5 working days unless approved in writing by the City's authorized representative.

d. **Connections:** Any connections to existing public utilities or newly constructed facilities proposed to be public utilities shall be made only with approval of the City's authorized representative. Connections shall be made only after all testing is completed on the new work and it is found to conform in all respects to the requirements of the plans and specifications, unless otherwise approved by the City's authorized representative. Prior to making connection(s) to existing facilities, contractor shall have all necessary pipe and fittings available and on-site.

e. **Cleanup:** Cleanup of all construction debris, excess excavation, and excess materials and complete restoration of all fences, mailboxes, ditches, culverts, signposts, and similar items shall be completed in conformance with Subsection 1.17.16, "Preservation, Restoration, and Cleanup."

1.17.3 City Inspection

a. The City's authorized representative shall inspect the project as necessary and shall check materials, equipment, and the construction of the project to determine whether the work is proceeding in accordance with the City's standards. The contractor shall notify the City's authorized representative at least 24 hours (one working day) to request City inspection. No such inspection, however, shall relieve the contractor of their duties under these standards.

b. The City's authorized representative shall have the authority to direct replacement of defective material and uncovering work not inspected as required. Material rejected by the City's authorized representative shall be removed from the job site by the contractor immediately after its rejection and shall not be used on the project.

c. Instructions given by the City's authorized representative shall be respected and executed by the contractor. The City's authorized representative, however, shall not have the power to waive the obligations of the contractor to furnish high-quality equipment, supplies, and materials, or to perform good work.

1.17.4 Change in Plans or Standards

The City's authorized representative shall have the right to make changes in the plans or in these standards to protect the public interest or the normal operations of the City. Such changes shall be made at the sole discretion of the City's authorized representative and may include, but are not limited to, the allowance of new or different materials for products that are equivalent to, or better than, the products specified in the plans or standards.

1.17.5 Interferences, Obstructions, and Abandoned Utilities

a. **Utility Notification:** The contractor shall comply with the rules and regulations of the Oregon Utility Notification Center: OAR 952-001-0010 through 952-001-0090 and ORS 757.993. At least 48 hours' notice shall be given to all utility offices that may be affected by the construction operation.

b. **General:** Various obstructions may be encountered during the course of the work. Maps and information regarding underground utilities shall be obtained from the utility owning and operating such utilities, but the location of such utilities is not guaranteed. If the

services of any utility are interrupted because of the construction operation, the contractor shall notify the utility owner and the City's authorized representative immediately.

c. **Protection:** The contractor shall exercise all due care in protecting existing underground and surface facilities and property along the route of the improvement. This protection shall include, but not be limited to, trees, yards, fences, drainage lines, mailboxes, driveways, shrubs, and lawns. Any existing facilities not specifically designated for alteration or removal that are damaged during construction shall be restored or replaced to an "in kind" or better condition, at the expense of the contractor.
d. **Access:** The contractor shall maintain access to all mail boxes; access to all property entrances shall be in conformance with Subsection 1.17.11, "Access for Police, Fire, and Postal Service."
e. **Abandoned Utilities:** All abandoned utilities shall be properly removed, grouted, or plugged at the discretion of the City's authorized representative.

1.17.6 Contaminated Soil

If during construction contaminated soil or with hazardous materials or chemicals are encountered, the Contractor shall follow the procedures specified in Subsection 1.18.2, "Contaminated Soils or Hazardous Materials."

1.17.7 Guarantee

a. The applicant/contractor shall furnish high-quality equipment, supplies, and materials and perform the work in accordance with these specifications. Any failure or omission by the City's authorized representative to condemn any defective equipment, supplies, materials, or work shall not be construed as an acceptance thereof nor release the contractor from their obligations.
b. On notification of any deficiency by the City's authorized representative, the contractor shall properly reconstruct or replace any defective equipment, supplies, materials, or work at their own cost any time on discovery of the defect during the period of construction and for the full guarantee period after acceptance of the work, and shall indemnify the City from any claims resulting from the defect.
c. The applicant/contractor shall guarantee all materials and equipment furnished and work performed for a minimum period of one year from the date of formal written acceptance by the City's authorized representative in conformance with Subsection 1.17.18, "Maintenance Assurance and Warranty."
d. The applicant/contractor shall further warrant and guarantee for a minimum period of one year from the date of formal written acceptance of the system that the completed system is free from all defects due to faulty materials or workmanship. The applicant/contractor shall promptly make such corrections as may be necessary by reason of such defects, including the repair of any damage to other parts of the system resulting from such defects.
e. If the applicant/contractor, after notice, fails within 10 days to proceed to comply with the terms of this guarantee, the City may have the defects corrected, and the applicant and the applicant's surety shall be liable for all expense incurred. However, in case of an emergency where, in the opinion of the Public Works Director, delay would cause serious loss or damage, repairs may be made without notice being given to the applicant/contractor and the applicant/contractor shall pay the cost thereof.

1.17.8 Substitution of Materials

Whenever any material, article, device, product, fixture, form, type of construction, or process is indicated or specified by patent or proprietary name, by name of manufacturer, or by catalog number, such specifications shall be for the purpose of establishing a standard of quality and facilitating the description of the material or process desired. Such specification is not to be

construed as eliminating from competition other products of equal or better quality made by other manufacturers and that are fully suitable in design, and shall be deemed to be followed by the words "or as approved" or "approved equal." The contractor may, in such cases, submit complete data to the Public Works Director for consideration of another material, type, or process that shall be substantially equal in every respect to the one indicated or specified. Substitute materials shall not be used unless approved in writing by the City's authorized representative. See also Subsection 1.11, "Approval for Alternate Methods or Materials".

1.17.9 Safety Requirements

a. The contractor shall at all times conduct work in such a manner as to comply with all Occupational Safety and Health Administration (OSHA) requirements, shall minimize the possibility of accident or injury of any workers or the general public, and shall conduct the work, maintain operations, and provide all reasonable safeguards so as to protect public and private property as well as to protect persons from injury.
b. If in the opinion of the City's authorized representative the contractor is in violation of the above safety practices, the City's authorized representative may issue and post a stop-work order if the contractor, after being informed of such violation, refuses to comply immediately. The City's authorized representative will also notify OSHA of such action.
c. The City's authorized representative's role is not one of supervision or safety management, but of observation only, as specified in Subsection 1.17.10, "Traffic Maintenance and Safety."

1.17.10 Traffic Maintenance and Safety

a. The contractor shall comply with all rules and regulations of City, county, or state authorities and applicable fire protection and law enforcement agencies regarding the closure of public streets or highways to public traffic. No public road shall be closed to the public except by express permission of the public agency responsible for the road.
b. The contractor shall conduct their operations so as to assure the least possible obstruction to traffic and normal commercial pursuits. Traffic control in work zones shall conform to the *Manual on Uniform Traffic Control Devices* (MUTCD 2009, or latest edition), published by the Federal Highway Administration, U.S. Department of Transportation and as amended by the Oregon Supplement to the MUTCD.
c. The contractor shall be required to submit a traffic control plan to the appropriate jurisdiction for review and approval before beginning construction.
d. The contractor shall provide and be responsible at all times for flaggers, signs, and other devices not otherwise specified to be furnished by the applicant. The contractor shall erect and maintain all barricades, guards, lights, variable message boards, standard construction signs, warning signs, and detour signs as are necessary to warn and protect the public at all times from injury or damage as a result of work operations on highways, roads, streets, sidewalks, multi-use paths, or recreational trails affected by such operations.
e. If the applicant or contractor fails to immediately provide the necessary flaggers or to provide, erect, maintain, and remove barricades, guards, lights, variable message boards, standard construction signs, warning signs, and detour signs when so ordered, the Public Works Director shall be at liberty, without further notice to the contractor or applicant, to do so and to deduct all costs from the applicant's/contractor's performance assurance.
f. When traffic will pass over backfilled trenches before they are paved, the top of the trench shall be maintained with cold patch or hot patch, to be removed later, and shall allow normal vehicular movement to continue. Access driveways shall be provided where needed. Cleanup operations shall follow immediately behind backfilling. The work site shall be kept orderly at all times.

g. When working in the public right-of-way, the contractor shall maintain the construction area in the interest of public health, safety and welfare, including, without limitation, maintenance of proper steel plates, trench backfill, patching, signage and lighting. It is the City's right, but not its obligation, to monitor contractor's compliance with this subsection. Upon discovery of non-compliance, or upon notice by the City's authorized representative, the contractor shall take immediate corrective action. If the contractor is not on site, and if, in the sole judgment of the City, conditions impose an immediate or eminent threat to public health, safety and welfare, the City has the right to perform emergency repairs or cause the repairs to be made, without notice and with all costs of such work being the responsibility of the contractor. Within sixty days of receipt of a detailed invoice for payment from the City, the contractor shall reimburse the City for costs incurred.
h. The City's authorized representative's role is not one of supervision or safety management, but of observation only. Nothing contained in this section or elsewhere in this document shall be interpreted to obligate the City to act in any situation, nor shift the applicant's responsibility for safety compliance to the City. No responsibility for the safety of the work or for construction means, methods, techniques, sequences, or procedures shall attach to the City by virtue of its action or inaction under this section.

1.17.11 Access for Police, Fire, and Postal Service

a. No closure of a part of a street shall be made without first requesting and receiving approval from the City's authorized representative. Closure of public streets shall be in conformance with Subsection 1.17.10, "Traffic Maintenance and Safety." The contractor shall conduct operations so as to cause the least interference with emergency vehicle access.
b. The contractor shall comply with all requirements of the U.S. Postal Service with regard to the location of mailboxes that must be disturbed during construction. Mailboxes may be moved to temporary locations designated by the Postal Service. At the completion of work in each area, the contractor shall replace the mailboxes in their original location and in a condition satisfactory to the Postal Service.

1.17.12 Compliance with Applicable Laws

a. The contractor shall keep fully informed of all local ordinances, including those of Molalla Fire District and state and federal laws and regulations that in any manner affect the work specified here.
b. The contractor shall at all times comply with said ordinances, laws and regulations, and shall protect and indemnify the applicant and his/her officers and agents against any claim or liability arising from or based on the violation of any such laws, ordinances, or regulations.
c. All permits, licenses, and inspection fees necessary for prosecution and completion of the work shall be secured by the applicant/contractor.

1.17.13 Work in Public Rights-of-Way

a. Closure of public streets shall be in conformance with Subsection 1.17.10, "Traffic Maintenance and Safety," and Subsection 1.17.11, "Access for Police, Fire, and Postal Service." Construction operations and traffic control shall be in conformance with Subsection 1.17.10, "Traffic Maintenance and Safety."
b. The contractor shall use every reasonable precaution to safeguard the persons and property of the traveling public. It shall be the sole responsibility of the contractor to furnish, place, and maintain barricades, barriers, lights, flares, danger signals, signs, and security guards as necessary to protect the persons and property of the traveling public. All barricades and obstructions shall be protected at night by signal lights that shall be suitably distributed and kept burning from sunset to sunrise.

c. In the event of interruption to domestic water, sewer, storm drain, or other utility services as a result of accidental breakage, or as the result of being exposed or unsupported, the contractor shall promptly notify the proper authority, cooperate with said authority in restoring the service as promptly as possible, and bear all costs of providing temporary service measures and repairs. In no case shall interruption of any water or utility services be allowed to exist outside working hours, unless prior approval by the City's authorized representative is received.
d. Work site cleanup shall be in conformance with Subsection 1.17.16, "Preservation, Restoration, and Cleanup."

1.17.14 Easements

The minimum utility and drainage easements for residential subdivisions shall be as follows:

a. Public utility easement along all front lot lines, as shown on approved plans, shall be 10 feet wide.
b. A 20-foot wide easement with an all-weather surface for maintenance access, as shown on approved plans. Lateral access shall not be greater than 800 feet.
c. Public sanitary, storm sewer, and water lines on private property shall be centered in a permanent easement granted to the City. Minimum width of a public pipeline easement shall be 15 feet. Easement width shall vary with depth of pipe installation. For pipe diameter greater than 36 inches or depth of bury greater than 15 feet, easement width will be determined by City's authorized representative. Such easements, when directed by the City, shall be accompanied by temporary easements granted to the City of adequate width to allow construction of water, storm, and sanitary sewers. The applicant's surveyor shall provide the City with documents in an approved format necessary to grant easements. The width of combination easements will be evaluated at the site development permit stage, but in no case shall they be less than 15 feet wide. When easements greater than 15 feet in width are created, the City will consider placement of parallel utilities if installed a minimum of 7.5 feet from edge of pipe.

    Easement Width (Single Pipe) = Pipe Depth x 2
    Easement Width (Double Pipe) = Pipe Depth x 2 + 7.5 feet

d. No permanent structures shall be allowed within an easement area.
e. Certain types of wooden fences, chain link fences, or other similar structures acceptable to the City's authorized representative may be allowed to be installed across and/or within easements.

1.17.15 Sanitation

Contractors shall provide and maintain adequate sanitary/sanitation facilities for employees.

1.17.16 Preservation, Restoration, and Cleanup

Site Restoration and Cleanup

a. The contractor shall keep the premises clean and orderly at all times during the construction period and leave the project free of rubbish or excess materials of any kind on completing the work. The contractor shall immediately replace mailboxes and signposts disturbed by construction activities.
b. During construction, the contractor shall stockpile the excavated trench materials so as to do the least damage to adjacent lawns, grassed areas, gardens, shrubbery, trees, or fences, regardless of the ownership of these areas. These surfaces shall be left in a condition equivalent to their original condition or better and free from all rocks, gravel, boulders, or other foreign material.

c. If damaged or altered during construction, existing trenches, drainage ditches, and culverts shall be regraded, and original drainage tiles and sewer laterals shall be repaired expeditiously. Within 500 feet of pipe-laying and backfilling operations in any trench section, the contractor shall rake and drag all disturbed areas and leave them free of rocks, gravel, clay, or any other foreign material and ready, in all respects, for seeding. The finished surface shall conform to the original or design surface, and shall be free-draining and free from holes, rough spots, or other surface features detrimental to a seeded area.
d. After backfilling the trenches, the contractor shall restore all public and private irrigation and/or utility systems that were destroyed, damaged, or otherwise modified during construction to their original condition or better.
e. All areas disturbed by the contractor's operations inside dedicated rights-of-way or easements shall be returned to their original condition or better. Areas outside the easements or rights-of-way that are disturbed by the contractor's operations shall be returned to their original condition or better.
f. All site restoration and cleanup work as described above shall be performed by the contractor within 5 working days of substantial completion of the work associated with the disturbance unless otherwise approved by the City's authorized representative.

Street Cleanup

a. The contractor shall clean spilled soil, mud, rock, gravel, or other foreign material caused by construction operations from all sidewalks, gutters, streets, and roads at the conclusion of each day's operation.
b. Within 5 working days of substantial completion of the project, including all paving, gravel shoulder resurfacing, and/or utility work, the contractor shall thoroughly remove all soil, mud, rock, gravel, and other foreign material from sidewalks, gutters, and paved surfaces.
c. Cleaning shall be by grader and front-end loader, power brushing, vacuuming, and hand labor, unless otherwise approved by the City's authorized representative. If the contractor does not follow these standards, the City may exercise its option to have the street(s) cleaned and bill the contractor for such service.
d. Within 5 working days of final completion of the project, the contractor shall remove all erosion-control materials and thoroughly remove all dirt, mud, rock, gravel, and other foreign material from sidewalks, gutters, catch basins, curb inlets, area drains and paved surfaces.

Preservation of Irrigation and Drainage Ditches

a. The contractor shall arrange schedules so that construction will not interfere with the irrigation of cultivated lands or pasturelands. Construction may proceed during the irrigation season provided the contractor constructs, at their own expense, temporary irrigation ditches, turnouts, and miscellaneous structures acceptable to the owner of the land in question that shall permit the land to be irrigated by others during construction.
b. After backfilling the trenches, the contractor shall restore all irrigation and storm drain ditches destroyed, damaged, or otherwise modified during construction to a condition equivalent, in the opinion of the City's authorized representative, to the condition of the ditches before construction. Ditches shall be built in their original locations.

1.17.17 Project Closeout

Project Completion: At the conclusion of the project, the applicant shall notify the City's authorized representative in writing that the project is ready for final inspection. On receipt of this notice, the City's authorized representative will request the following:

a. **Record Drawings:** At the completion of construction, the design engineer shall perform a record survey. That survey shall be the basis for the preparation of record drawings that will

serve as the physical record of changes made to the approved plans or specifications during construction.

- The engineer shall submit, along with the record drawings, a statement certifying all work for which plans were approved has been completed in accordance with the Molalla Public Works Design Standards and Standard Specifications and design documents.
- The words "Record Drawing" shall appear as the last entry in the revision block along with the month, day and year the record drawings were prepared.
- Using the record survey as a guide, the appropriate changes shall be made and a complete set of record drawings shall be submitted on paper to the City for review.
- The actual location and depth from finish grade of any other utilities encountered during construction shall be noted on record drawings.
- Once approved, a final set of approved record drawings will be submitted in Mylar™ material (minimum 4-mil thickness) or heavier double matted static free polyester film.
- The review set of the Record Drawings must be received before the City's authorized representative issues a project correction list (commonly known as punch-list). Record drawings shall include all work done within the public right-of-way or public easements.

b. **AutoCAD Drawing:** An electronic copy of the record drawings in AutoCAD format (check with City for acceptable versions) and scaled Adobe PDF shall be submitted to the City's authorized representative on a compact disk, thumb drive, or by internet file transfer. Electronic record drawings must be received before the City's authorized representative issues a written notice of project completion.

c. **Final Inspection:** Once the City's authorized representative receives the Mylar and electronic record drawings, a final inspection of the project will be conducted by the City's authorized representative.

d. **Project Correction List:** After this inspection, a project correction/repair list (punch-list) will be issued by the City's authorized representative to the applicant and contractor. The project correction/repair list will include any items either damaged or improperly placed during construction, and any item(s) that, in the opinion of the City's authorized representative, need repair.

e. **Project Corrections:** Contractor shall perform correction/repair work as required on the project correction/repair list. The City encourages the contractor to complete all correction/repair work as expeditiously as possible; the City will retain the performance assurance until the project correction list has been completed, and inspected and approved by the City's authorized representative, and the contractor submits all maintenance and landscape maintenance assurances to the City.

f. **Completion:** When all items of the project correction list have been completed, re-inspected, and approved by the City's authorized representative, and the contractor provides the City with maintenance assurance and warranty as specified in Subsection 1.17.18, "Maintenance Assurance and Warranty", the City's authorized representative will consider the project complete and shall state so in writing. The one-year warranty period will go into effect on the date of the written notice of project completion from the Public Works Department.

1.17.18 Maintenance Assurance and Warranty

Maintenance Assurance: Maintenance assurances shall be required for work to ensure post-construction quality and landscape survivability. Assurances shall be in the form of a letter of commitment, letter of credit, assignment of deposit, bond, or cash deposit, in form and substance satisfactory to the City and meeting the requirements in Subsection 1.15.9, "Qualifications of Insurance and Bonding Companies".

a. **Construction maintenance assurance:** A one-year bond for 20% of the cost to construct public improvements. Prior to the end of the one-year bond, the City will provide contractor with a maintenance project corrections list; the City reserves the option to video inspect the sanitary and/or storm sewer lines. Contractor shall make all necessary repairs and replacements to remedy any and all defects, breaks, or failures of the public improvements as identified by the City and having occurred within one year following the date of completion due to faulty or inadequate materials or workmanship, in a manner satisfactory to the City's authorized representative and at no cost to the City. Contractor shall repair damage or disturbances to other improvements under, within, or adjacent to the public improvements, whether or not caused by settling, washing, or slipping, when such damage or disturbance is caused, in whole or in part, from activities of the Contractor in performing his/her duties and obligations under this Contract when such defects or damage occur within the warranty period. Bond shall be released after acceptance of construction and after correction of all defects identified during the maintenance assurance period.
b. **Prompt compliance:** If Contractor, after written notice, fails within 10 days to proceed to comply with the terms of this section, Owner may have the defects corrected, and Contractor and Contractor's Surety shall be liable for all expense incurred. In case of an emergency where, in the opinion of the Engineer, delay would cause serious loss or damage, repairs may be made without notice being given to Contractor and Contractor or Surety shall pay the cost of repairs. Failure of the Engineer to act in case of an emergency shall not relieve Contractor or Surety from liability and payment of all such costs.
c. **Water lines:** In addition to provisions a. and b. above, City of Molalla water line facilities installed by the contractor under the Public Works Permit contract that require repair or replacement during the one-year maintenance period shall be repaired by the City or under direct supervision of the City. The Contractor and Contractors surety will be liable for all expenses.
d. **Landscape maintenance assurance:** a two-year bond for 100% of the cost to install all required landscaping in water quality/quantity facilities and vegetated corridors, *plus* 100% of the cost to maintain the landscaping in these areas for two years. The assurance shall be released two years after acceptance of construction, providing the landscaping meets the 90% survival level (see Subsection 3.13.2, "Landscape Inspection for Warranty").
e. **Final Completion:** A project shall meet final completion when the City's authorized representative receives confirmation that all easements and legal documents have been recorded with the County Recorder.

1.18 ENVIRONMENTAL PROTECTION, EROSION PREVENTION, AND SEDIMENT CONTROL

1.18.1 Introduction

This section identifies requirements for erosion prevention and sediment control. The provisions are intended to prevent or reduce adverse impacts to the City's drainage system and water quality. In combination with other federal, state, and local laws and ordinances, the requirements are intended to protect the beneficial uses of state waters.

1.18.2 Contaminated Soils or Hazardous Materials

If construction reveals soils contaminated with hazardous materials or chemicals, or if soil is suspected to be contaminated, the contractor shall cease earthwork activity immediately, ensure that no contaminated material is hauled from the site, remove their workforce from the immediate vicinity of the contaminated area (leaving all machinery and equipment), and secure the area from access by the public until an OSHA certified HAZMAT response team has relieved them of that responsibility. The contractor shall immediately notify the City's authorized

representative, the design engineer, and the Oregon Department of Environmental Quality (DEQ) of the situation.

1.18.3 General Policy

Erosion Prevention Techniques and Measures

a. The use of erosion prevention techniques shall be emphasized, rather than measures to control sediment. This shall be especially important on construction sites immediately before and during the rainy season. Erosion prevention techniques are designed to protect soil particles from the force of rain and wind so they shall not erode. When land is disturbed at a construction site, the erosion rate accelerates dramatically.
b. Erosion prevention techniques include, but are not limited to, construction scheduling, ground cover, and matting. Sediment control measures are designed to capture soil particles after they are dislodged and to retain the soil particles on site.
c. Erosion prevention measures include, but are not limited to, silt fences, sediment barriers, and settling basins. Both erosion prevention techniques and sediment control measures have appropriate uses. Studies have shown, however, that sediment control measures are less effective than erosion prevention techniques in preventing soil movement.
d. Permanent vegetation or seeding shall be established only between March 1 through May 15 and September 1 through October 15. If an irrigation system is installed, vegetation or seeding may be established from March 1 through October 15. If an area falls under definition of a wetland, permanent vegetation or seeding shall be established only between March 1 through April 30 and September 1 through October 15 and in a manner satisfying applicable local, state and federal requirements.
a. Permanent vegetation or seeding shall meet the 90% survival level as detailed in Subsection 3.13.2, “Landscape Inspection for Warranty”.

Existing Vegetation

a. Existing vegetation shall be protected and left in place whenever practicable. Work areas shall be carefully located and marked to reduce potential damage to trees and existing vegetation. Trees shall not be used as anchors for stabilizing working equipment. Where required, trees and existing vegetation shall be protected with a non-movable, chain link fence.
b. Where existing vegetation has been removed, or the original land contours have been disturbed, the site shall be revegetated, and the vegetation established, as soon as practicable.

Enforcement

Failure to comply with any provision of this section or with any term of an erosion-prevention and sediment-control permit shall be deemed a violation and subject to enforcement action pursuant to applicable State statutes, State agency policies, City ordinances, resolutions, and orders, including all implementing rules and regulations.

1.18.4 Erosion Prevention and Sediment Control

Application and Purpose

a. It is a City goal to eliminate or minimize to the extent feasible all sediment and other pollutants reaching the public storm and surface water system resulting from development, construction, grading, excavating, clearing, and any other activity that accelerates erosion, to the limits prescribed in these standards.
b. It is the policy of the City to require temporary and permanent measures for all construction projects to lessen the adverse effects of construction on the environment. All projects shall have a current DEQ 1200-C permit, as required by the state, and include properly installed, operated, and maintained temporary and permanent erosion-control measures as provided

in these standards or in an approved plan, designed to protect the environment during the term of the project. Compliance with the measures prescribed here or in an approved plan do not lessen the necessity to provide effective and comprehensive erosion prevention and sediment control.

c. It is the permit holder's responsibility to comply with DEQ 1200-C requirements and DEQ's responsibility to enforce the permit requirements. Nothing in this section shall relieve any person of the obligation to comply with the regulations or permits of any federal, state, or local authority.

Erosion Prohibited

a. Visible or measurable erosion that enters, or is likely to enter, the public or private stormwater and surface water system or other properties is prohibited and is a violation of these standards. An offsite sedimentation control facility may be utilized if it has been identified and approved in writing by the City's authorized representative, written approval is obtained from the respective property owner, and a written agreement for rehabilitation of the facility by the applicant or contractor is submitted to the City. The owner of the property or the applicant under a Public Works Permit, together with any person or persons, including but not limited to the contractor or the design engineer causing such erosion, shall be held responsible for violation of the City's standards.

b. No person shall create physical erosion by dragging, dropping, tracking, or otherwise placing or depositing, or permitting to be deposited, mud, dirt, rock, or other such debris on a public street, or into any part of the public stormwater and surface water system, or into any part of a private stormwater and surface water system that drains or connects to the public stormwater and surface water system. Any such deposited material shall be immediately removed by hand labor or mechanical means. No material shall be washed or flushed into any part of the stormwater and surface water system until all mechanical means to remove the debris are exhausted and preventive sediment filtration is in place.

c. The owner of the property or the applicant under a Public Works Permit, together with any person or persons, including but not limited to the contractor or the design engineer who causes such erosion, shall be held responsible for violation of these Standards.

Erosion-Prevention Techniques and Methods

a. The techniques and methods described in the latest edition of Clackamas County Water Environment Services "Erosion Prevention and Sediment Control Planning and Design Manual" may be used to control and prevent erosion in addition to the following procedures:

    a. **Gravel Construction Entrance**

        (a) A gravel construction entrance is required for all construction projects unless otherwise approved by the Public Works authorized representative. If there is more than one vehicle access point, a gravel construction entrance shall be required at each entrance.

        (b) For project sites 5 acres or greater in size, a wheel wash will be required to be constructed. For sites less than 5 acres in size, a wheel wash may be required if, in the opinion of the City's authorized representative, excess tracking of soil occurs.

        (c) The responsibility for design and performance of the driveway remains with the applicant. Vehicles or equipment shall not enter a property next to a stream, watercourse, stormwater or surface water facility, or wetlands unless adequate measures are installed to prevent physical erosion into the water or wetland.

    2. **Erosion Control**

        (a) During periods of wet weather, disturbed areas of the site and/or stockpiled soil shall be covered by tarps or straw at the end of each day's operations; all disturbed, unworked areas of the site shall be protected from erosion.

(b) Temporarily seed disturbed soils and slopes that are not at finished grade and which will be exposed for two months or longer before being disturbed again.
(c) Where seeding is used for erosion control, Regreen® or equivalent, or sterile wheat shall be used to stabilize slopes until permanent vegetation is established.
(d) Temporary seeding shall establish a minimum of 70% coverage of the ground surface with uniform healthy plants. If this coverage is not achieved, or if the City determines that it is not effective in stabilizing the soil from erosion, the contractor, at their expense, shall stabilize the area with other temporary stabilization methods as approved by the City's authorized representative.
(e) Biodegradable fabrics (Coir/Jute Matting), reinforced turf mats, or straw mulch can be used to stabilize slopes and channels. The fabrics can also be used to hold plugs in place and discourage floating upon inundation. Consult the *Erosion Prevention Planning and Design Manual (EPPDM)* for additional information.
(f) Permanent vegetation shall be established as outlined in "Erosion Prevention Techniques and Measures."

3. **Bioengineering Techniques**
   (a) Any person performing work in a watercourse or in an environmentally sensitive area (e.g., essential salmonid habitat, wetlands, and steep slopes) shall employ bioengineering techniques whenever feasible.
   (b) Bioengineering techniques include, but are not limited to, contour wattling, brush layering or matting, live cuttings, fascines, and stakes.
4. **Sediment filters/barriers**
   (a) Using straw bales as a sediment filter or barrier is not allowed.
   (b) A filter system may not be used on catch basins in public streets as part of erosion-prevention and sediment-control plans for single-family dwellings.
5. **Plastic Sheeting:** Plastic sheeting shall generally not be used as an erosion-control measure for single-family house construction. Plastic sheeting may be used to protect small, highly erodible areas or temporary stockpiles of material. If plastic sheeting is used, the path of concentrated flow from the plastic must be protected.
6. **Protection Measure Removal:** The erosion-prevention and sediment-control measures shall remain in place and be maintained in good condition until all disturbed soil areas are permanently stabilized by installation and establishment of landscaping, grass, or mulching, or are otherwise covered and protected from erosion.
7. **Wet Weather Measures:** On sites where vegetation and ground cover have been removed, vegetative ground cover shall be planted on or before September 1, with the ground cover established by October 15. As an alternative if ground cover is not established by October 15, the open areas shall be protected through the winter with mulch, erosion blankets, or other method(s) approved by the City's authorized representative.
8. **Exceptions to Sediment Barrier Requirements:** Sediment barriers are not required on a site in the following circumstances:
   (a) Where a Neighborhood Erosion Control Plan is in effect, for a maximum of four lots.
   (b) Where there are no concentrated flows and the slope being protected has a grade of less than 2%.
   (c) Where flows are collected by using temporary or permanent grading or other means, such that the flows are routed to an approved settling pond, filtering system, or sediment barrier.
   (d) Where there are no concentrated flows, where slopes are less than 10%, and where the runoff passes through a grassed area that is either owned by the applicant or

where such use is allowed, by written agreement, by the owner of the grassed area. The grass area shall be at least equal in dimension to the project area.

(e) Where the surface is protected by ground cover or matting approved by the City's authorized representative.

Dust Prevention

During all phases of the work, the contractor shall take precautions to abate any dust nuisance. Dust-prevention measures shall be continuous until final inspection by the City's authorized representative. Dust shall be minimized to the extent practicable, using all measures necessary to accomplish results satisfactory to the City's authorized representative, including, but not limited to:

- Sprinkling haul and access roads and other exposed dust-producing areas with water.
- Applying City-approved dust palliatives on access and haul roads.
- Establishing temporary vegetative cover.
- Placing wood chips or other effective mulches on vehicle- and pedestrian-use areas.
- Maintaining proper moisture conditions on all fill surfaces.
- Pre-wetting cut and borrow area surfaces.
- Using covered haul equipment

Neighborhood Erosion Control Plan

a. Any individual or group may submit an erosion-prevention and sediment-control plan for multiple lots. Plans shall be submitted to City of Molalla for review and approval. This shall be referred to as a "Neighborhood Erosion Control Plan." In such case, the group of lots will be evaluated as if they were one lot.
b. If an individual lot in a Neighborhood Erosion Control Plan is sold to new owners, the new owners may either join the neighborhood plan (with the approval of the other neighborhood owners) or will need to submit their own erosion control plan if erosion potential still exists on the parcel. If a lot is sold and the new owner does not join the Neighborhood Erosion Control Plan, then the plan must be revised, and the new owner must submit an individual plan.

1.18.5 Maintenance

a. The applicant shall maintain the facilities and techniques contained in the approved erosion-prevention and sediment-control plan, so they will continue to be effective during the construction phase, post construction phase, establishment of permanent vegetation, or any other permitted activity.
b. If the facilities and techniques approved in an erosion-prevention and sediment-control plan are not effective or sufficient as determined by the City site inspection, the applicant shall submit a revised plan within three working days of written notification by the City's authorized representative. On approval of the revised plan by the City's authorized representative, the applicant shall immediately implement the additional facilities and techniques included in the revised plan.
c. In cases where erosion is likely to occur, the City's authorized representative may require the applicant to install interim control measures before submitting a revised erosion-prevention and sediment-control plan.

1.18.6 Inspection

a. **City Initial Inspection:** On a site development or any other type of project, the erosion-prevention and sediment-control measures shall be installed before the start of any permitted activity. The applicant shall call the City's authorized representative for a pre-construction conference before beginning any site clearing or grading.

b. **Applicant Inspections**: The applicant shall be required to inspect erosion-prevention and sediment-control measures as outlined in the approved Grading and Erosion Control Plan and to provide information to the City's authorized representative. Inspections shall be completed as required by the latest edition of the *Erosion Prevention Planning and Design Manual* and the Minimum Erosion Prevention and Sediment Control Plan Monitoring Requirements. Inspection information is to be maintained on-site and available to City's authorized representative on request.
c. **Final Inspection:** A final erosion control inspection shall be required before the sale or conveyance to new property owner(s) or before the removal of erosion-prevention and sediment-control measurements.

SECTION 2 – STREET IMPROVEMENT DESIGN & CONSTRUCTION STANDARDS

2.1 ENGINEERING

2.1.1 Introduction

This section outlines design and construction requirements for all public street construction. The provisions and technical specifications herein set forth the requirements of the City of Molalla for roadway construction and improvements. Interpretations of such provisions and their application in specific circumstances shall be made by the City's authorized representative. Refer to Section 1 for general provisions and requirements. All street designs shall provide for the safe and efficient travel to the motoring public. Streets shall be designed to carry the recommended traffic volumes identified for each street classification. Streets shall be designed to meet or exceed minimum guidelines. These guidelines are set forth in the "AASHTO Policy on Geometric Design of Highways and Streets" (latest edition). Traffic Control Devices shall conform to the "Manual on Uniform Traffic Control Devices for Streets and Highways," Federal Highway Administration, with Oregon Supplements, Oregon Dept. of Transportation's (latest edition)

2.1.2 Alternative Designs

a. If approved by the Public Works Director, alternative roadway design standards may be substituted for the standards specified herein. Any requests for substitution must be in writing, stamped by a Professional Engineer registered in the State of Oregon at the time of submittal, and submitted as part of the Land Use process.
b. If approved by the Public Works Director, alternative construction standards may be substituted for the standards specified herein. Any requests for substitution must be in writing, stamped by a Professional Engineer registered in the State of Oregon at the time of submittal, and submitted at least three weeks prior to the Engineering Plan Review submittal process.
c. In developing a drainage plan for stormwater management, the design engineer is encouraged to provide, to the extent feasible, on-site Stormwater management through the use of Low Impact Development (LID) principles as provided in Section 3.

2.1.3 General Requirements

a. **Functional Classification:** The functional classification of existing and proposed roads is established by the City of Molalla's Transportation Systems Plan (TSP). Where the functional classification of a road is not defined by the TSP, the existing land use and existing operational characteristics shall be used by the Public Works authorized representative to determine the functional classification of the road in question.
b. **Access:** Access to city, county, and public roads shall conform to the City of Molalla TSP.
c. **Width:** The width of the streets shall be in compliance with the City of Molalla TSP and using **Table 2.1**.

Table 2.1 STREET AND RIGHT-OF-WAY WIDTHS

Type of Street	Right-of-Way	Roadway
Arterial Molalla Ave (Shirley-Toliver)	60	46

Arterial Molalla Ave Other Than Downtown District	60	46
Arterial Molalla Ave (Heintz-3rd)	60	40
Arterial OR 213 and OR 211 Other Than Downtown District	68	52
Arterial OR 211 (Fenton-Mathias)	60	38
Arterial OR 211 (Shaver-Fenton)	60	40
Arterial at Intersection	60	40
Major Collector Toliver (OR 213-Molalla)	60	34
Major Collector Shirley (Molalla-Park)	60	46
Major Collector at Intersection	60	46
Major Collector (Molalla Forest Road)	60	34
Minor Collector/Neighborhood	50	36
Minor Collector/Neighborhood at Intersection	50	34
Local	50	34
Cul-de-sac	50	45
Alley	24	20

d. **Number of Lanes:** The number of lanes for each class of road is defined by the City of Molalla TSP.
e. **Sidewalks and Planter Strips:** Streets shall be provided with sidewalks and planter strips as specified in the City of Molalla TSP.
f. **Design Speed:** The posted vehicle speed can be 85% of design speed, unless the road improvement will increase the 85% speed. If road improvement is likely to increase the 85% speed, the design speed will be as follows using **Table 2.2**.

Table 2.2 DESIGN SPEED

Type of Street	Speed (mph)
Arterial (State)	Varies
Arterial (City)	30
Collector	30
Local	25
Cul-de-sac	25

2.1.4 Transportation Impact Analysis/Transportation Analysis Letter

Transportation Impact Analysis (TIA) is required for developments that are expected to have an impact on the transportation system. The analysis shall be based upon the latest edition of the ITE Trip Generation Manual or an agreed-upon alternative methodology where credible data is available to support the alternative methodology. When specific criteria generally associated with small developments are met, a Transportation Analysis Letter (TAL) may be substituted for the required TIA. At the discretion of the City Engineer, a TAL may satisfy the City's transportation analysis requirements, in lieu of a TIA, when a development meets all the following criteria:

a. The development generates fewer than 25 peak hour trips during either the AM or PM peak hour. (Two examples of common developments generating fewer trips than these threshold levels are: a subdivision containing 25 or fewer single-family residences or a general office building less than 15,000 square feet.).
b. The development is not expected to impact intersections that currently fail to meet the City's level of service standards or intersections that are operating near the limits of the acceptable level of service thresholds during a peak operating hour.
c. The development is not expected to significantly impact adjacent roadways and intersections that are high accident locations, areas that contain an identified safety concern, or high concentration of pedestrians or bicyclists such as school zones.
d. The development generates an increase in use of adjacent streets by vehicles exceeding the 20,000-pound gross vehicle weights by less than 10 vehicles per day.

Transportation Analysis Letter Contents. If the City determines based on information provided by the applicant and in accordance with the criteria specified above that a TAL is the appropriate document to submit, the following requirements shall apply.

a. The TAL shall be prepared by or prepared under the direct supervision of a Registered Professional Engineer who shall sign and stamp the TAL.
b. The TAL shall include the following:
    1) The expected trip generation of the proposed development including the AM peak hour, the PM peak hour, daily traffic, and other germane periods as may be appropriate, together with appropriate documentation and references.
    2) Site plan showing the location of all access driveways or private streets where they intersect with public streets plus driveways of abutting properties and driveways on the opposite side of the street from the proposed development.
    3) Documentation that all site access driveways meet City of Molalla Private Access Driveway Width Standards.
    4) Documentation that all site access driveways meet City of Molalla's Minimum City Street Intersection Spacing Standards.
    5) Documentation that all new site accesses and/or public street intersections meet AASHTO intersection sight distance guidelines.
    6) Documentation that there are no inherent safety issues associated with the design and location of the site access driveways.
    7) Documentation that the applicant has reviewed the City's TSP and that proposed streets and frontage improvements do or will comply with any applicable standards regarding the functional classification, typical sections, access management, traffic calming and other attributes as appropriate.

Transportation Impact Analysis Contents. The following information shall be included in each TIA submitted to the City. Additional information specified by the City in the scoping summary or through the pre-application meeting or other project meetings shall also be included.

a. Completed TIA checklist signed by the Professional Engineer responsible for the preparation of the TIA.
b. Table of Contents – Listings of all sections, figures, and tables included in the report.
c. Executive Summary – A summary of key points, findings, conclusions, and recommendation including a mitigation plan.
d. Introduction, including:
    1) Proposed land use action including site location, zoning, building size, and project scope
    2) Map showing the proposed site, building footprint, access driveways, and parking facilities.
    3) Map of the study area that shows site location and surrounding roadway facilities.
e. Existing Conditions:
    1) Existing site conditions and adjacent land uses.
    2) Roadway characteristics of important transportation facilities and modal opportunities located within the study area, including roadway functional classifications, street cross-section, posted speeds, bicycle and pedestrian facilities, on-street parking, and transit facilities.
    3) Existing lane configurations and traffic control devices at the study area intersections.
    4) Existing traffic volumes and operational analysis of the study area roadways and intersections.
    5) Roadway and intersection crash history analysis.
    6) Intersection and stopping sight distance related to new and impacted driveways and intersections.
f. Background Conditions (without the proposed land use action):
    1) Approved in-process developments and funded transportation improvements in the study area.
    2) Traffic growth assumptions.
    3) Addition of traffic from other planned developments.
    4) Background traffic volumes and operational analysis.
g. Full Buildout Traffic Conditions (with the proposed land use action):
    1) Description of the proposed development plans.
    2) Trip generation characteristics of proposed project (including trip reduction documentation).
    3) Trip distribution assumptions.
    4) Full buildout traffic volumes and intersection operational analysis.
    5) Site circulation and parking. vi. Intersection and site-access driveway queuing analysis.
    6) Recommended roadway and intersection mitigation measures (if necessary).
h. Conclusions and recommendations
i. Appendix- With dividers or tabs
    1) Traffic count summary sheets.
    2) Crash analysis summary sheets.
    3) Existing, Background, and Full Buildout traffic operational analysis worksheets with detail to review capacity calculations.
    4) Signal, left-turn, and right-turn lane warrant evaluation calculations.
    5) Signal timing sheets depicting the timing and phasing used in analysis.
    6) Other analysis summary sheets such as queuing.

j. To present the information required to analyze the transportation impacts of development, the following figures shall be included in the TIS:
   1) Vicinity Map
   2) Existing Lane Configurations and Traffic Control Devices
   3) Existing Traffic Volumes and Levels of Service for each required time period
   4) Future Year Background Traffic Volumes and Levels of Service for each required time period
   5) Proposed Site Plan, including access points for abutting parcels and for those across the street from the proposed development
   6) Future Year Assumed Lane Configurations and Traffic Control Devices
   7) Estimated Trip Distribution/Assignment Pattern
   8) Trip reductions (pass-by trips at site access (es))
   9) Site-Generated Traffic Volumes for each required time period
   10) Full Buildout Traffic Volumes and Levels of Service for each required time period

2.1.5 Street Plans

a. It is the design engineer's responsibility to ensure that engineering plans are sufficiently clear and concise to construct the project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill the intent of the design guidelines in these standards.
b. All elevation on design plans and record drawings shall be based on the applicable datum specified in Section 1.
c. All engineering street plans shall be stamped by a Professional Engineer registered in the State of Oregon. At a minimum the street plan shall contain the following:
   1. At least one sheet showing a plan view of the entire project site. If the project site is sufficiently large that detailed street plans on any given sheet do not encompass the entire project site, then a sheet showing the plan view of the entire site must serve as an index to subsequent detailed plans sheets.
   2. A topographic map showing existing conditions for the site, including:
      (a) Existing topography for the site.
      (b) Adjacent streets, including street names.
      (c) Existing utilities, including franchised utilities above or below ground and drainage facilities that transport surface water onto, across, or from the project site. Existing drainage pipes, culverts, and channels shall include the invert or flow line elevations.
      (d) Existing sensitive areas (e.g., ravines, swales, steep slopes, wells, springs, wetlands, creeks, lakes). For natural drainage features, show direction of flow, drainage hazard areas, and 100-year floodplain boundary (if applicable).
   3. Plans for proposed street improvements shall include the following:
      (a) Grading and erosion control plan.
      (b) Finished grades, showing the extent of cut and fill by existing and proposed contours, profiles, or other designations.
      (c) Curb return elevation data.
      (d) ADA ramp elevation data for the four corners of the ramp; also, for connecting sidewalks up to a maximum distance of 15 feet out from ramp when running slopes exceed the general grade established for the adjacent street.
      (e) Proposed structures, including roads and road improvements, parking surfaces, building footprints, walkways, landscaped areas, street lighting, public and private utilities, etc.
      (f) Signing and striping plan.

(g) Lighting and illumination plan.
(h) Applicable detail drawings.
(i) Existing and proposed easements.
(j) Setbacks from environmentally sensitive areas or wetland.
(k) Any proposed phasing of construction. (Note: water quality and quantity facilities must be constructed before completion of any phased construction)

4. Detailed grading and landscape plans will be provided. The plans shall include the following:
   (a) Existing ground contours (shaded) and proposed ground contours at a minimum of a 1-foot contour interval. Slopes steeper than 6H:1V shall be identified.
   (b) Location of all drainage structures as well as any other piped utilities in vicinity (i.e., at 0.1-foot detail).
   (c) Landscape planting plan. Show all sewer laterals, water services, fire hydrants, and street lighting.
   (d) Irrigation plan to achieve the required plant survival rate.
   (e) Maintenance access, as applicable.
5. Cross-sections shall be provided for at least the following:
   (a) All street sections or amended soil sections, as applicable.
   (b) Proposed ditches and swales, including vegetated swales.

2.1.6 Surveying

a. The design engineer shall be responsible for establishing the location of the street by means of reference stakes offset along the centerline. No construction shall be allowed to begin before construction staking. All staking shall be performed by or under the direction of a Professional Land Surveyor registered in the State of Oregon.
b. Reference stakes shall be set at 50-foot station intervals along the centerline. Stakes shall, at a minimum, reference the following:
   1. Point of Curvature (PC), midpoint, Point of Tangency (PT) for horizontal curves.
   2. Begin Vertical Curve (BVC) point, low/high point, End Vertical Curve (EVC) point for vertical curves.
   3. Beginning and ending point of super-elevation.
   4. Beginning and ending of full super-elevation.
   5. Centerline of intersecting street.
   6. PC, midpoint, and PT for curb returns.
   7. Centerline of access (wheelchair) ramp.
   8. Centerline of driveways.
   9. Curb scoring for match into concrete street joints.
c. The design engineer shall also be responsible for identifying easements during construction.

2.1.7 Streets Adjacent to Railroad Right-of-way

Wherever the proposed subdivision contains or is adjacent to a railroad right-of-way, provision may be required for a street approximately parallel to and on each side of such right-of-way at a distance suitable for the appropriate use of the land between the streets and the railroad. The distance shall be determined with due consideration at cross streets of the minimum distance required for approach grades to a future grade separation and to provide sufficient depth to allow screen planting along the railroad right-of-way.

2.1.8 Streets with Marginal Access

Where a subdivision abuts or contains an existing or proposed arterial street, the hearings officer may require marginal access streets, reverse frontage lots with suitable depth, screen planting contained in a non-access reservation along the rear or side property line, or such other

treatment as may be necessary for adequate protection of residential properties to afford separation of through and local traffic.

2.2 STREET DESIGN

Streets shall be designed by a Professional Engineer registered in the State of Oregon. Two copies of the stamped and signed street design calculations shall be provided to the City.

2.2.1 Subgrade Evaluation

a. Subgrade evaluation and recommendations shall be prepared, stamped and signed by a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering and shall be summarized in a Geotechnical Report. Two copies of this Geotechnical Report shall be provided to the City.
b. Soil testing to obtain the strength of the soil is required for all roads to analyze and design the road structural section. Soil tests are needed on samples of subgrade materials that are expected to be within 3 feet of the planned subgrade elevation. Samples are needed for each 1,000 feet of roadway and for each visually observed soil type. Soil tests are required for at least two locations.
c. The selected design structural strength of the soil must be consistent with subgrade compaction requirements. That is, the strength and compaction moisture content at optimum to slightly over optimum must be specified. The Geotechnical Report shall address subgrade drainage and groundwater considerations for year-round conditions. Recommendations for both dry-weather and wet-weather construction shall be included.
d. Test the subgrade and determine the modulus of subgrade reaction, k, or the resilient modulus (M_R) to design the street structure. The procedure for determining M_R is given in AASHTO T-292. Alternately, these soil strength criteria can be based on either the California Bearing Ratio (CBR) or H-veem resistance testing (R-value). The CBR will be determined in accordance with AASHTO T-193, based on the modified proctor (AASHTO T-180). R-values shall be determined at 300-psi exudation pressure in accordance to AASHTO T-190.
    1. A correlation of M_R to CBR is given by the following relationship (Heukelom and Klomp, 1962):
        M_R (psi) = 1,500 x CBR
    2. A correlation of M_R to R-value is given by the following relationship (Asphalt Institute, 1982):
        M_R (psi) = A + B x (R-value)
        Where A = 772 to 1,155, B = 369 to 555
    3. A correlation of M_R to R-value for fine-grained soils (R-value ≤ 20) is given by the following correlation (AASHTO, 1993):
        M_R = 1,000 + 555 x (R-value)
    4. A correlation of CBR to k may be made using **Table 2.3**.

Table 2.3. RELATIONSHIP BETWEEN CBR AND k

CBR Value	Modulus of Subgrade Reaction (k) (psi/in.)
3	100
5.5	150
10	200
20	250
50	500

80	710

SOURCE: Portland Cement Association (PCA).

2.2.2 Subsurface Drainage

Subsurface street drainage must be considered in the design of each street:

a. Subsurface drains shall be designed and constructed according to the recommendations of the Geotechnical Report. In the event that no subsurface drainage is required based on the Geotechnical Report, a transverse perforated drainpipe with a minimum diameter of 4 inches shall be installed below the base rock at the point of each sag vertical curve.
b. The subsurface drains are for the purpose of collecting and conveying subsurface water only, not surface runoff. They are not to be considered part of the storm drainage system for purposes of sizing storm drain pipe.
c. Subsurface drains shall connect and drain into the storm drainage system at catch basins, gutter inlets, manholes, or roadside ditches. Surcharge from the storm drainage system shall not be allowed to back up into the subsurface drains.
d. Alternative subsurface drainage measures may be used if approved by the City's authorized representative.

2.2.3 Structural Section

a. Arterial or Collector Streets may be constructed of:
    1. AC with crushed aggregate base and/or treated bases and subgrade geotextile fabric, or
    2. PCC with crushed aggregate base and subgrade geotextile fabric.
b. Residential Streets may be constructed of:
    1. AC with crushed aggregate base and/or treated bases and subgrade geotextile fabric, or
    2. PCC with crushed aggregate base and subgrade geotextile fabric, or
    3. Standard or permeable segmental concrete pavers with crushed aggregate base and subgrade geotextile fabric, or
    4. A combination of the two methods above, with the concrete pavers separated from the AC and PCC by a flush curb.

2.2.4 Crushed Aggregate Design

When crushed aggregate is included in the pavement design section, it shall consist of 1½" - 0 crushed aggregate. The base rock shall be separated from native subgrade soils using a geotextile fabric to prevent fine material from migrating up into the base rock. Minimum aggregate base thickness shall be a minimum eight (8) inches for Local streets and twelve (12) inches for Collector and Arterial streets.

2.2.5 Asphalt Pavement Design

a. AC pavement shall be designed using nationally recognized procedures: the AASHTO method or the Asphalt Institute method.
b. The wearing surface of AC pavement shall conform to the Oregon Department of Transportation Standard Specifications for Construction (ODOT SSC) Section 00745, "Hot Mixed Asphalt Concrete," for either Level 2 or Level 3 HMAC, as determined by the City's authorized representative. Minimum total thickness of AC on local streets shall be four (4) inches placed in at least two lifts. Minimum total thickness of AC on collector and arterial streets shall be six (6) inches placed in at least two lifts. Minimum lift thickness shall be 2"; maximum lift thickness shall be 3". The base courses for AC pavement shall conform to ODOT SSC Section 00745, "Hot Mixed Asphalt Concrete," for either Level 2 or Level 3 HMAC, as determined by the City's authorized representative.

c. Pavement thickness design criteria shall be accomplished in accordance with the AASHTO method or the Asphalt Institute method, using soil strength criteria based on either the CBR or R-value (see Subsection 2.2.1, "Subgrade Evaluation").
d. Use a minimum 20-year design period.

2.2.6 Portland Cement Concrete Pavement Design

a. At the direction of the City's authorized representative, certain streets may be required to be designed and constructed using PCC.
b. PCC pavement shall be designed using nationally recognized procedures: the PCA method or the AASHTO method.
c. Use a minimum 30-year design period.
d. Minimum thickness of PCC shall be seven (7) inches.
e. Minimum thickness of crushed rock base shall be six (6) inches.
f. PCC for pavement construction shall conform to ODOT Class 4350 – 1 ½, Structural Concrete or Structural Concrete Option A.
g. Design of concrete joints shall follow the guidelines and requirements outlined in the American Concrete Pavement Association (ACPA) publication, "Design and Construction of Joints for Concrete Streets," except for the following:
    1. Maximum joint spacing shall be 12 feet.
    2. Joints shall be designed to be skewed 6:1 when meeting the edge of pavement.
    3. For doweled contraction joints, do not lubricate the dowels.
    4. Isolation joints shall be used around manhole covers. Isolation joints shall be circular with a 3-foot spacing from the manhole cover.
h. All castings for manholes in concrete streets shall be standard type.
i. PCC for curbs, sidewalks, and miscellaneous construction shall conform to ODOT Class 3300 – ¾, Commercial Grade Concrete.

2.2.7 Pavement Transition – Portland Cement Concrete to Asphalt

Where PCC paving abuts AC paving, there shall be a lateral transition zone extending 4 feet, with a cross-section designed according City standard details.

2.2.8 Segmental Concrete Paver Design

a. The City's authorized representative may approve the design and construction segmental concrete paver roadway on local residential streets.
b. Segmental concrete pavement shall be designed using nationally recognized procedures: the ICPI method for municipal streets and roadways.
c. Where segmental concrete pavement transitions to AC or PCC pavement, a lateral concrete band shall be used as an edge restraint.

2.2.9 Pavement Overlay Design

Pavement overlays shall be designed using nationally recognized procedures: The Asphalt Institute method, PCA method, or AASHTO method.

2.2.10 Horizontal Alignment

Alignments shall meet the following requirements:

a. Centerline alignment of improvements should be parallel to the centerline of the right-of-way. The centerline of a proposed street extension shall be aligned with the existing street centerline
b. Horizontal curves in alignments shall meet the minimum radius requirements as follows:
    1. Arterial: 415' – 600'
    2. Collectors: 165' – 275'

3. Local and Cul-de-sac: 100’

2.2.11 Vertical Alignment

Alignments shall meet the following requirements:

a. Minimum longitudinal street gradients shall be 1% along the crown and curb.
b. Maximum street centerline gradients shall be 6% percent for arterial streets, 8% for collector streets, and 10% for local streets. Grades in excess of 8% but not more than 12% may be permitted for short distances and must be approved by the City’s authorized representative on an individual basis.
c. Local and cul-de-sac streets may exceed 12% with the City’s authorized representatives’ approval, but in no case permitted to exceed 16%, and only under the following conditions:
    1. Topographic constraints do not allow the development to be served by a street with a maximum grade of 12% without causing de-stabilization of soils by excessive cuts and fills.
    2. There is no access to the property being developed through adjacent properties at a maximum 12% grade.
    3. The section of Local Street will not exceed a combination of length, horizontal alignment, and/or grades exceeding 12% which will create hazardous traffic conditions.
    4. In no case shall the maximum street grade exceed 16%.
d. Cross-slope of the street section shall be no less than 2% and no greater than 5%.
e. Local streets intersecting with a minor collector or greater functional classification street or streets intended to be posted with a stop sign shall provide a landing that averages 5% gradient or less. Landings are that portion of the street within 20 feet of the edge of the intersecting street at full improvement.
f. Grade changes of more than 1% shall be accomplished with vertical curves.
g. Street grades, intersections, and super-elevation transitions shall be designed not to allow concentrations of storm water to flow over the pavement.
h. Offset crowns may be allowed and must be approved by the City’s authorized representative on an individual basis.
i. Streets intersected by streets not constructed to full urban standards shall be designed to match both present and future vertical alignments of the intersecting street. The requirements of these standards shall be met for both present and future conditions.
j. Vertical curves shall conform to the values listed in **Tables 2.4 and 2.5**.
k. Slope easements shall be dedicated or obtained for the purposes of grading outside the right-of-way.

Table 2.4. DESIGN CONTROLS FOR CREST VERTICAL CURVES BASED ON STOPPING SIGHT DISTANCE

Design Speed	K
25	20 – 30
30	30 – 40
35	40 – 50
40	60 – 80
45	80 – 120

Where: K = L / A = feet / percent.
L = length of vertical curve (feet).
A = algebraic difference in grades (percent).

Table 2.5. DESIGN CONTROLS FOR SAG VERTICAL CURVES BASED ON STOPPING SIGHT DISTANCE

Design Speed	K
25	30 – 40
30	40 – 50
35	50 – 60
40	60 – 70
45	70 – 90

Where: K = L / A = feet / percent.
L = length of vertical curve (feet).
A = algebraic difference in grades (percent).

Note: Values may be reduced if street lighting is present for sag vertical curves. AASHTO publication, "An Informational Guide for Roadway Lighting" (1984), shall serve as a guide.

2.2.12 Transitions

The following specify the minimum requirements for street transitions:

a. Street width transitions from a narrower width to a wider width shall be designed with a 5:1 taper. Delineators, as approved by the City's authorized representative, shall be installed to define the configuration.
b. For street width transitions from wider to narrower, the length of the transition taper shall be determined as follows:

   $L = S \times W$, for $S \geq 45$ mph

   $L = \frac{W \times S^2}{60}$, for S less than 45 mph

   Where: L = minimum length of taper (feet).
   S = design speed (mph).
   W = edge of pavement offset (feet).
c. Delineators, as approved by the City's authorized representative, shall be installed to define the configuration. Maximum spacing of delineators shall be the numerical value of the design speed, in feet (i.e., a 35-foot spacing for a 35-mph speed).
d. In situations where a tapered transition cannot be provided, a Type III barricade shall be installed at the end of the wider section of the street and a taper shall be appointed and delineated as approved by the City's authorized representative. The barricade shall conform to City details; diagonal striping shall slope down in the direction of the taper. If the wider section does not provide an additional travel lane, only a barricade is required without the transition.

2.2.13 Super-elevation Cross-Sections

a. Design elements for super-elevation shall be based on AASHTO design guidelines.
b. Offset crown cross-sections are not acceptable as super-elevation sections.

2.2.14 Intersections

The following specifies the minimum requirements for intersections:

a. Connecting street intersections shall be located to provide for traffic flow, safety and turning movements, as conditions warrant.
b. The interior angle at intersecting streets shall be kept as near 90 degrees as possible, unless existing development or topography make it impracticable. Where intersecting streets cannot be kept at right angles, the interior angle shall in no case be less than 75 degrees, unless approved by the City's authorized representative after consultation with the Molalla

Fire District. A tangent section shall be carried a minimum of 25 feet each side of intersecting right-of-way lines.

c. Opposing intersections shall be designed so that no offset dangerous to the traveling public is created.
    1. Intersection distances shall be measured from right-of-way centerline to right-of-way centerline.
    2. Intersections on Molalla Forest Road shall be separated by at least 800 feet
    3. Intersections on major collector/arterial streets shall be separated by at least 600 feet.
    4. Intersections on local streets shall be separated by at least 300 feet.
d. Curb radii at intersections shall be as shown in **Table 2.6** for the various function classifications with exceptions subject to approval by the City's authorized representative. The right-of-way radii at intersections shall be sufficient to maintain at least the same right-of-way-to-curb spacing as the lower classified street.
e. Sidewalk access ramps shall be in conformance with Subsection 2.2.28, "Sidewalks"

Table 2.6. MINIMUM TURNING RADII FROM EDGE OF PAVEMENT OR CURB (feet)

Street Classification	Arterial	Collector	Residential
Arterial	30	30	20
Collector	30	30	20
Residential	20	20	20
Truck Route	30	30	30

Streets serving commercial/industrial properties may be required to install larger curb radius as required for vehicle movements. In the opinion of the Public Works Director, truck turning movements may be required to verify sufficient curb radius. The Public Works Director will determine the size of vehicle used.

2.2.15 Cul-de-Sacs, Eyebrows, Turnarounds

The design engineer's plans must be approved by Molalla Fire District and the City's authorized representative. The following specifies the minimum requirements for cul-de-sacs, eyebrows, and turnaround areas. Other turnaround geometrics may be used when conditions warrant and when the City's authorized representative approves the design and application of its use.

a. Cul-de-sacs and other turnaround areas shall be allowed only on residential streets and commercial/industrial streets that cannot be extended or connected into the street network. Cul-de-sacs shall not be more than 400 feet long, unless approved by the Molalla Fire District and the maximum length shall be 800 feet long. Cul-de-sac are measured from the near side of the intersecting street to the farthest point of the cul-de-sac.
b. The minimum curb radius for cul-de-sac bulbs shall be 45 feet, and the right-of-way radius shall be sufficient to maintain the same right-of-way-to-curb spacing as in the adjacent part of the road. When an island or parking bay is provided, there shall be a fire apparatus land of 20 feet in width along the entire perimeter of the cul-de-sac
c. Cul-de-sacs and other turnaround areas shall have a 10-foot public utility easement extending outside the right-of-way around the cul-de-sac continuously.
d. An eyebrow corner may be used on a local street where expected average daily traffic (ADT) counts will not exceed 500 vehicles.

2.2.16 Stub Streets

Stub streets allow for future extension of the roadway. A reserve strip at the terminus of the right-of-way shall be provided. The reserve strip shall be at least one foot long and extend the full width of the right-of-way and be provided to the City. A Type III Street Barricade conforming to City standards shall be erected at the edge of pavement of the stub street and "No Parking" signs installed on the barricade; a Type II Sidewalk Barricade conforming to City standards shall be erected at the end of any sidewalks on the stub street. Additionally, a sign shall be installed stating the street will be extended in the future and to contact the City of Molalla Public Works Department (503-829-6855) for further information. Streets 50 feet in length or greater shall provide a garbage/recycling vehicle turn around approved by the City's authorized representative.

2.2.17 Permanent Dead-End Streets

A standard cul-de-sac turnaround shall be provided at the end of a permanent dead-end street that does not provide looped circulation. Permanent dead-end streets shall be limited to serving no more than eighteen dwellings and shall not exceed 450' in length from the point of the nearest centerline/centerline intersection.

A permanent dead-end street is measured from the right-of-way line at the nearest intersecting street, which has at least two points of access, to the right of way line at the furthest end of the dead-end street.

An existing dead-end street system which is more than 450' long or which serves more than 25 dwelling units may be terminated in a cul-de-sac if no Future Street Plan has been adopted and the following criteria are met:

a. Alternative emergency vehicle access or fire protection is provided satisfactory to the local Fire Authority; and,
b. Neighborhood traffic circulation needs are not adversely impacted by the proposed cul-de-sac termination of the street.

Temporary dead-end streets more than one-hundred-fifty (150) feet in length shall be provided with an approved turn-around for emergency vehicles.

2.2.18 Half Streets

Street widening construction is generally not acceptable. Where such a Street is justified, the right-of-way and pavement width will be approved by the Public Works Director. In no case shall the pavement width be less than that required to provide two lanes of traffic to pass at a safe distance. Half streets will only be approved when the abutting or opposite frontage property is undeveloped, and the full improvement will be provided with development of the abutting or opposite (upon right-of-way dedication) frontage property. Half street improvements shall include curb, sidewalk and storm drainage on one side of the street. When a half street improvement is required, the entire street shall be designed. A development on an unimproved street shall be responsible for constructing a continuous City standard street to a connection with the nearest standard (publicly-maintained) street.

Whenever a half street improvement is approved, it shall conform to the following:

a. Street section design and construction shall be in conformance with these standards.
b. Minimum pavement width shall be 25 feet for arterial and major collector streets, and 20 feet for minor collector and local streets.
c. Intersectional improvements shall be adequate to provide turn lanes where required. See Table 2.1.
d. A reserve strip at the limits of the right-of-way shall be provided to the City. The reserve strip shall be at least one foot wide, extend the full width of the right-of-way, and access control shall be governed by the City.

2.2.19 Street Widening

Where pavement is installed next to existing pavement and at all trench cuts, the existing pavement shall be saw cut a minimum of 1 foot from the edge of pavement. The face of the joint between the new and existing pavement shall be coated with asphalt emulsion and the surface of the joint shall be sand sealed.

Where existing pavement is cut for utility or other construction, a permit must be obtained from the City. Backfill shall be Controlled Density Fill (CDF) to pavement thickness requirements in accordance with Subsection 2.2.5, "Asphalt Pavement Design" or Subsection 2.2.6, "Portland Cement Concrete Pavement Design".

2.2.20 Shoulders

Where sidewalks and pavement end or where there is no curb and sidewalk (such as half-street improvements) shoulder rock shall be provided to grade with the pavement. Shoulder rock shall be a minimum of six (6") inches in depth, thirty-six inches (36") wide and shall be ¾"-0 crushed rock.

2.2.21 Private Streets

Private streets are prohibited unless otherwise approved by the City Council. If approved by City Council, the private street shall meet the following requirements:

a. Private streets shall meet the requirements of the Molalla Fire District.
b. Private streets shall not be used for ingress and egress into mixed use developments.
c. Private streets shall be designed with the same structural section as the adjacent residential street or designed in conformance with these Standards.
d. Storm systems not designated as public and only serving private streets shall be private storm systems.
e. Private streets shall be constructed and inspected in conformance with these Standards.
f. Private streets shall be signed with a blue street name sign in conformance with Subsection 2.8.1, "Street Name Signs and Posts"; in addition, all private streets shall be signed with a blue sign stating, "Street not maintained by the City of Molalla."
g. Maintenance of the private streets and storm drainage systems shall be the responsibility of the Applicant or their successors. The Applicant shall form an association prior to final approval of the improvements. The association shall collect fees for the management and maintenance of the private streets and private storm systems.
h. The Applicant shall sign an irrevocable waiver of remonstrance encompassing the entire development served by the private street. In the event the Applicant or their successors fail to maintain the private street, the City will form a local improvement district. The City will perform repairs or reconstruction of private streets and allocate all costs, including administration, in the form of a lien to all affected properties. All liens not paid in full within 30 days will accrue interest at a variable rate not less than the interest rate cost to the City plus City administrative costs. The irrevocable waiver of remonstrance will remain in place and the Applicant or their successors will be required to maintain the private streets.
i. Private streets and the private tracts shall remain private and not be converted into public right-of-way.

2.2.22 Alleyways

Alleyways may be provided in commercial and industrial developments with approval by the City's authorized representative. When approved, alleyways shall be dedicated to the city. The right of way width shall be 24 feet with a 20-foot pavement width and 2-foot gravel shoulders on both sides.

Design for alleyways shall meet the same criteria as other public streets. The exceptions to those criteria may be centerline radius and design speed. Generally, alleyways shall be designed for one-way operations.

2.2.23 Raised Medians and Traffic Separators

The following specify the minimum requirements for raised medians:

a. Raised center medians and landscape medians are allowed and encouraged where feasible on certain arterials and major collector streets as defined in the City of Molalla TSP.
b. Where raised medians are allowed, the following criteria must be met:
    1. Objects, such as trees, shrubs, signs, light poles, etc., shall not physically or visually interfere with vehicle or pedestrian traffic in the travel way.
    2. The style and design of the raised median shall be site specific. The raised median shall be safe for the design speed. Raised medians shall be designed in conformance with AASHTO guidelines.
    3. Design shall be in conformance Curb and Gutter Style as provided in Subsection 2.2.27, "Curbs and Grading Outside of Street" and consider the use of rolled curbs and appropriate surface loading for emergency vehicle left-turn access. Raised median designs shall be subject to City approval.
c. Concrete traffic separators shall be designed where they are needed as determined by the City's authorized representative; concrete traffic separators shall conform to these design standards.

2.2.24 Transit Turnout Design

The need for and location of transit turnouts shall be determined by Public Works Director.

a. Transit turnouts shall conform to City standards details.
b. Transit pad sections shall be a minimum thickness of 9 inches of PCC over 6 inches of compacted base rock.
c. Transit pad shall be reinforced with No. 4 reinforcement steel bar, placed 1-foot on center each way, 2 inches above base rock.
d. Transit pad shall be doweled into adjacent PCC gutter; dowels spaced 3-feet on center and centered on face of gutter. If adjacent street is PCC, transit pad shall be doweled into the street as shown in the City Standard Details.
e. PCC for transit pad construction shall conform to ODOT Class 4350 – 1½, Structural Concrete or Structural Concrete Option A.
f. Base rock shall be in conformance with Subsection 2.3.1, "Granular Fill."
g. Design of concrete joints shall follow the guidelines and requirements outlined in the ACPA publication, "Design and Construction of Joints for Concrete Streets," except for the following:
    1. Maximum joint spacing shall be 12 feet.
    2. Joints shall be designed to be skewed 6:1 when meeting the edge of pavement.
    3. For transit pads adjoining PCC streets, joints shall match street jointing.
    4. For doweled contraction joints, do not lubricate the dowels.
    5. Isolation joints shall be used around manhole covers. Isolation joints shall be circular with a 3-foot spacing from the manhole cover.

2.2.25 Sight Distance

A clear vision area shall be maintained on each corner of property at the intersection of any two streets, a street and a railroad, or a driveway and a street. Clear vision area shall be in conformance with City Code and this standard. The following specifies the minimum requirements for sight distance for roads that intersect each other, and for driveways that intersect roads:

a. The minimum intersectional sight distances shall be based on the posted speed of the road. The intersectional sight distance shall be
    1. Based on an eye height of 3.5 feet and an object height of 2.0 feet above the road surface.
    2. Measured at the center of the drive lane 10 feet from the extended curb line or edge of pavement of the crossroads.
b. No structures, plantings, or other obstructions shall be allowed that would impede visibility between the height of 30 inches and 10 feet, as measured from the top of curb, or in absence of a curb, from the established street centerline elevation.
c. Trees placed in sidewalk planting areas must be located at least 30 feet from the nearest intersection and 10 feet from driveways.
d. Minimum intersectional sight distance for railroad and street intersections shall be in conformance with AASHTO design guidelines.
e. Minimum intersectional sight distance shall be equal to 10 times the posted speed of the road for grades of 3% or less, as shown in **Table 2.7.** For grades in excess of 3%, sight distances must be adjusted and shall be in conformance with AASHTO design guidelines. For significant road improvement projects, the following intersectional standards shall be met in addition to the AASHTO remaining sight distance standards.

Table 2.7. INTERSECTIONAL SIGHT DISTANCE

Design Speed (mph)	Distance Along Crossroads (feet)
25	250
30	300
35	350
40	400
45	450

2.2.26 Driveways

Access to private property shall be permitted with the use of driveway curb cuts. The access points with the street shall be the minimum necessary to provide access while not inhibiting the safe circulation and carrying capacity of the street.

On Collector streets and above, one driveway per site frontage will be the normal maximum number. Double frontage lots and corner lots on these streets may be limited to access from a single street, usually the lower classification street. If additional driveways on a frontage are approved by the City's authorized representative, a finding shall be made that no eminent traffic hazard would result and impacts on through traffic would be minimal. Restrictions may be imposed on additional driveways, such as limited turn movements, shared access between uses, closure of existing driveways, or other access management actions.

Driveway approach types including residential driveway, commercial/industrial driveways, must be approved by the City's authorized representative.

Should the length of a driveway be greater than fifty (50) feet in length and the driveway has only one (1) access to the street or does not loop to the street, a turnaround shall be provided. The minimum inside radius of the turn-around shall be fifteen (15) feet with a width at the turnaround point of thirty (30) feet for maneuvering.

The following specifies the minimum requirements for driveways:

a. Driveways shall conform to City standards details.

b. Driveways shall not be permitted on streets with existing non-access reserve strips, or where plat restrictions limit access to the right-of-way, or as set forth in the TSP.
c. For commercial or industrial developments, driveway access shall be a minimum of 100 feet from the nearest intersection (as measured from centerline of driveway to near face of curb at intersection), unless otherwise approved in writing by the City's authorized representative.
d. For residential developments, driveway access from the nearest intersection shall be a minimum of 50 feet (as measured from centerline of driveway to near face of curb at intersection) unless otherwise approved in writing by the City's authorized representative.
e. Driveway widths to flag lots shall meet requirements of Molalla Fire District.
f. Grading on driveways shall not exceed twelve percent (12%).
g. Concentrated surface runoff shall not be allowed to flow from private commercial/industrial property into the public right-of-way.
h. Driveways intersecting with roads shall meet the minimum sight distance requirements as specified in Subsection 2.2.25, "Sight Distance."
i. Driveway Widths (Min./Max.) are as follows:
    1. Single Family Residential: 12'/24', one driveway per parcel.
    2. Multi-family Residential: 24'/30', one driveway per parcel or development.
    3. Commercial: 30'/40', one driveway per parcel or per access management requirements.
    4. Commercial: 30'/40', one driveway per parcel or per access management requirements.

2.2.27 Curbs and Grading Outside of Street *(Revised 03/12/21)*

The following specifies the requirements for curbs and cross-slope grading for streets:

a. **Location and Design:** arterial, collector and residential streets shall include curb and gutters on both sides, except in some situations of interim width improvements. Interim designs shall be reviewed and approved on a case by case basis by the City's authorized representative. Non-mountable curb and gutters shall be required on arterial, collector and residential streets.
b. **Curb and Gutter Style:** On edges of streets or where designed to carry water, curb and gutter shall be designed in conformance with City standard details. At street medians or where designed to spill water, curb and gutter shall be designed with reverse gutter pan in conformance with City standard details. In all cases, the gutter shall be a minimum depth of six (6) inches or shall match the design depth of the AC or PCC street pavement section.
c. **Curb Joints:** Joint spacing in curbs shall be 12-foot maximum for contraction joints and 48-foot maximum for expansion joints. In addition, expansion joints shall be located at all curb return points and at driveway curb drop transition points. A minimum of two drainage block-outs to accommodate 3" drain pipe shall be provided for each lot. Typically, these block-outs are located approximately five feet (5') from each side property line.
d. **Shoulders**: rural streets or interim width urban streets shall have minimum 6-foot-wide shoulders next to the street, at 2% cross-slope, and roadside ditches on each side of the shoulder, with a maximum side slope of 2H:1V. The 6-foot shoulder area shall consist of a minimum of 4 feet of pavement and 2 feet of crushed aggregate.
e. **Gutter Stamping:** newly constructed public curb and gutters or replaced curb and gutters shall be stamped on the top of the curb with the capital letters "S" at the location of each sanitary lateral crossing, the capital letters "D" at the location of each storm drain lateral crossing, the capitol letter "W" at the location of each water line crossing, and the capitol letter "C" at the location of each conduit crossing. Letters shall be 3 inches in height and embossed a minimum of ⅛-inch deep.
f. **Root Barriers:** where trees are located within 8 feet of public curbs, they shall be protected from root intrusion with a root control barrier system designed by a Professional Landscape

Architect registered in the State of Oregon; root control barrier shall be approved by the City's authorized representative before installation. Generally, the root control system should be installed a minimum of 24 inches deep, with a minimum 20-foot length centered on the root source. Installation of such systems shall be done so as to not disturb the curb or base rock previously installed. Provide landscaping plan showing location of root control barrier system.

g. **Grading, Collector and Arterial Streets:** grading outside the improved areas shall be as follows: Minor collector or higher functional classification shall have a 2% upward grading to the right-of-way line, a 5H:1V upward or downward grading within the public utility easement, and no steeper than 1½H:1V up or 2H:1V down outside the right-of-way. Retaining walls shall be used if slopes are greater than the 1½H:1V to a height where the slope is no more than 1½H:1V.

h. **Grading, Residential and Rural Streets:** residential streets and rural roads shall have a 2% upward grading to the right-of-way line, a 5H:1V upward or downward grading within the public utility easement, and no steeper than 1½H:1V up or 2H:1V down, outside the public utility easement. Retaining walls shall be used if slopes are greater than the 1½H:1V to a height where the slope is no more than 1½H:1V.

2.2.28 Sidewalks

The following specifies the requirements for sidewalks:

a. **Location and Design**: The location of sidewalks shall be based on the City of Molalla TSP, the City's Parks and Trails Plan in accordance with this subsection. Sidewalks shall be designed with following minimum widths:
   1. Arterial (OR 213 & Other): 6 feet
   2. Arterial (Downtown District): 10 feet
   3. Arterial (OR 211 Shaver-Mathias): 10 feet
   4. Major Collector: 6 feet
   5. Major Collector (Molalla Forest Road): 12 feet
   6. Minor Collector/Neighborhood: 6 feet
   7. Local: 6 feet
   8. Cul-de-sac: 6 feet

   Sidewalk thickness, slope, finish work, and location of expansion and contraction joints shall be as specified in the City detail drawings. Final facility location and design are subject to the approval of the City's authorized representative.

b. **Easements:** All public-owned pedestrian facilities shall be constructed within a public right-of-way or an easement. All new development or redevelopment shall consider access to adjacent properties in their development plans, especially schools, retail, and commercial areas. Easements shall be provided as necessary for compliance with the ADA Standards for Accessible Design.

c. **Access Ramps:** Access ramps shall be included in the design of sidewalks at all corners of all intersections, regardless of curb type or terrain. Access ramp design shall be in conformance with the ADA Standards for Accessible Design, as amended in 1994. For areas not fully addressed in these ADA Standards, the ADA Accessibility Guidelines (ADAAG), as amended in 2002, or the 2005 Draft Public Rights-of-Way Accessibility Guidelines will be followed as determined by the Public Works Director. On streets classified as collector or above and at intersections that have a major street classification, double access ramps shall be installed. Ramps shall have a smooth transition at the gutter line.

d. **Thickened Design:** At all intersections adjacent to the curb radius, curb-tight sidewalks and sidewalk ramps shall be constructed with a similar section as shown for a residential driveway.

e. **Root Barriers**: Where trees are located within 8 feet of public sidewalks, they shall be protected from root intrusion with a root control barrier system designed by a Professional Landscape Architect registered in the state of Oregon; root control barrier shall be approved by the Public Works Department authorized representative before installation. Generally, the root control system should be installed a minimum of 24 inches deep, with a minimum 20-foot length centered on the root source. Installation of such systems shall be done so as to not disturb the sidewalk, curb or base rock previously installed. Provide landscaping plan showing location of root control barrier system.

2.2.29 Bike Lanes

The need for bike lanes shall be determined by the City, based on the TSP. Bike lanes, bike paths, and multi-use paths shall meet the requirements of these standards, as described in Section 7, "Bicycle and Pedestrian Facility Standards".

Table 2.8. On Street Parking

Street/Pathway Class	Minimum Width	Comments
Arterial (State)	8' buffered	Each Direction
Arterial (City)	6'	
Collector	6'	Each Direction
Local	None	None
Cul-de-sac	None	None
Off-Street Path	6'	One-way Travel
Off-Street Path	10'	Two-way Travel
Off-Street Path w/Ped.	8'	One-way Travel
Off-Street Path w/Ped.	12"	Two-way Travel

All paths shall be constructed with 2' gravel shoulders on both sides. All bike ways shall have a minimum cross slope of two percent (2%) and a maximum cross-slope of five percent (5%) On curved alignments, the cross-slope shall be to the inside of the curve. Bikeway curvature will be based on a minimum design speed of 20 mph. Bikeway grades shall be limited to a maximum of five percent (5%). Where topography dictates, grades over five percent (5%) are acceptable when a higher design speed is used, and additional width is provided.

Off-street bike ways shall be constructed for two different situations. The two situations are: Where limited maintenance vehicle (City-owned) use will occur, and where heavy maintenance vehicle use will occur. In both cases, sub grade preparation will require removal of existing organic material and compaction. A subgrade geotextile fabric shall be used under base aggregate.

Bikeway thicknesses shall meet the following requirements:

Table 2.9. Bikeway Sections

Use	Asphalt (Concrete)	Aggregate
Limited	2" (4")	6"
Heavy	3" (6")	8"

When drainage, such as side ditches, is required parallel with the bike way, the ditch centerline shall be at least five feet (5') from the edge of the pavement. Ditch side slope adjacent to the bike way shall be no steeper than 2:1 when measuring the horizontal distance to the vertical distance. When culverts cross bike ways, the ends of the pipe shall be no closer than five feet (5') from the edge of the bike way.

2.2.30 Bike Path Crossings

Bike paths intersecting with roadways require physical barriers to deter use by unauthorized motor vehicles. A lockable, removable post(s) may be used to discourage such use and still permit authorized vehicles to access the paths. The post shall be brilliantly colored and permanently reflectorized. If more than one (1) post is required, the spacing shall not exceed a separation of more than five (5) feet. An alternative to deterring the motor vehicles is to design two (2) five (5) foot wide lanes separated by low landscaping at the intersection.

2.2.31 Parking

Table 2.9. On Street Parking

Street Class	Parking Lanes	Parking Required
Arterial	2	Per TSP
Major Collector	2	Per TSP
Minor Collector/Neighborhood	2	Per TSP
Local	2	Per TSP
Cul-de-sac	2	Per TSP

Note: No parking within 20’ of marked crosswalk.

For streets designated collector and below, the Public Works Director may consider design modifications to conserve major trees in the public right-of way. Subject to approval by the Public Works Director, parking lanes may be removed on one or on both sides of a street. Design standards - parking and loading.

a. Scope.
    1. These design standards shall apply to all parking, loading and maneuvering areas.
    2. All parking and loading areas shall provide for the turning, maneuvering and parking of all vehicles in the lot.
b. Access.
    1. Where a parking or loading area does not abut directly on a public street there shall be provided an unobstructed drive and not less than 20 feet in width for two-way traffic, leading to a public street, and traffic directions shall be plainly marked.

Parking area improvements. All public or private parking areas which contain three or more parking spaces and outdoor vehicle areas shall be improved according to the following.

a. All parking areas shall have durable, dust free surfacing of asphaltic concrete, Portland cement concrete or other approved materials. The design section shall conform to the use and the soils report. All parking areas, including those in conjunction with a single family or two-family dwelling, shall be graded so as not to drain excess storm water over the public sidewalk or onto any abutting public or private property.
b. All parking areas, except those required in conjunction with single family or two-family dwellings or vehicle sales areas, which abut a residential district, shall conform to the screening requirements as set forth in the city's site design ordinance.
c. All parking areas, except those required in conjunction with single family or two-family dwellings or vehicle sales areas may contain a maximum of 25% of the parking spaces sized for compact vehicles.
d. All required handicapped parking space shall conform to the Americans with Disabilities Act (ADA), ORS 447.210, and City Parking Standards and shall be a minimum of 14 feet in width.
e. All parking areas, except those required with single family or two-family dwellings or vehicle sales areas, shall have physically marked individual parking spaces such as painted lines, lettering, curbs and landscaping.

Table of Standards. The following table provides the minimum dimensions of parking stall, length and width, aisle width and maneuvering space, of public or private parking areas. All parking facilities shall meet these minimum standards. The width of each parking space includes a four inch (4") wide stripe which separates each space. Compact spaces are noted in parenthesis:

Table 2.10. Parking Stall Dimensions

Angel from Curb	Stall Width "A"	Channel Width "B"	Aisle Width "C"	Curb Length per stall "D"
Parallel	9' 0" (8'6")	9' 0" (8'6")	12' 0" (12' 0")	23" 0" (20' 0")
30°	9' 0" (8'6")	16' 10" (14' 10")	12' 0" (12' 0")	18" 0" (17' 0")
45°	9' 0" (8'6")	19' 1" (16' 7")	14' 0" (14' 0")	12' 9" (12' 0")
60°	9' 0" (8'6")	20' 1" (17' 3")	18' 0" (18' 0")	10' 5" (10' 3")
90°	9' 0" (8'6")	18' 0" (15' 0")	24' 0" (24' 0")	9' 0" (8' 6")

2.2.32 Guardrails

The following specify the minimum requirements for the location and type of guardrails:

a. The decision whether to install a guardrail shall be based on information in the AASHTO publication, "Guide for Selecting, Locating, and Designing Traffic Barriers," or most recent edition.
b. Guardrails shall be designed in conformance with AASHTO design guidelines and constructed according to ODOT SSC Section 00810, "Metal Guardrail."

2.2.33 Roadside Ditches

Roadside ditches shall be designed in conformance with Subsection 3.7.3, "Channel Construction for New Roadside Ditches".

2.2.34 Utilities

The following specifies the minimum requirements for utilities:

a. Franchised utilities shall be located underground, outside the paved road if possible, to avoid future cuts in pavement.
b. A Public Utility Easement (PUE) shall be required adjacent to rights-of-way on all frontages to public roadways; PUE widths shall be as provided in conformance with Subsection 1.17.14, "Easements," and the City's detail drawings. PUE's shall be graded as per Subsection 2.2.27, "Curbs and Grading Outside of Street," from back of curb or sidewalk unless otherwise approved by the City's authorized representative. Earthen berms or any other encroachments are not allowed within a PUE.
c. On all phased (interim) road improvements, the necessary utilities shall be stubbed across the interim improvement to assure that cuts are not necessary when the road is expanded to its full width. A 5-year moratorium will prohibit street cuts on all projects. The moratorium begins when a project is complete, and the warranty begins. Check with the Public Works Department for a current list of streets on the 5-year moratorium.
d. Except for sanitary sewers, storm sewers and water mains, underground utilities intended to provide direct service to adjacent properties with future connections shall not be located in the full-width paved section of a street to be constructed.
e. Underground utilities that must cross an existing paved street shall not be installed by any method that cuts the pavement, unless approved by the City's authorized representative.
f. Underground utilities shall be buried a minimum depth of 36 inches, measured from finished grade to top of utility.

2.2.35 Mailboxes

Joint mailbox facilities shall be provided in all residential developments, with each joint mailbox serving at least two (2) dwelling units.

a. Joint mailbox structures shall be placed adjacent to roadway curbs.
b. Proposed locations of joint mailboxes shall be designated on as part of the development plan and shall be approved by the City's authorized representative.
c. Plans for the joint mailbox structure to be used shall be submitted as part of the development plan for approval by the City's authorized representative.

2.2.36 Retaining Walls

Private Property Walls – Retaining walls shall be self-supported and not be located within a public easement or public right of way. Retaining walls shall not require anchoring or any other structural support that relies on public right of way or public easement. Retaining walls adjacent to public right of ways or public easements that are greater than four (4) feet in height or support a surcharge shall be designed by a Professional Engineer licensed in the State of Oregon and require a Public Works permit for construction. No retaining wall shall All costs for plan review, permitting, and independent inspection by the City will be at the owner's expense. Site plans shall include property lines, adjacent streets and easements, property addresses, north arrow, distance between buildings and retaining wall, impervious areas, all engineering calculations and soil reports.
Public Retaining Walls – Retaining walls shall be self-supported and designed by a Professional Engineer licensed in the State of Oregon, regardless of wall height, and be incorporated into a City project plan set.

2.3 MATERIAL SPECIFICATIONS

2.3.1 Granular Fill

a. Crushed aggregate for base rock, leveling course, and surface replacement shall consist of an aggregate base as specified by the design engineer, with approval of the City's authorized representative, and shall be in conformance with ODOT SSC Section 02630, "Base Aggregate," for gradation, fractured faces, and durability. The leveling course shall consist of ¾"-0 grade crushed aggregate material and be a minimum thickness of 2 inches when compacted.
b. The aggregate shall consist of uniform-quality, clean, tough, durable fragments of rock or gravel, free from flat, elongated, soft, or disintegrated pieces, and other objectionable matter occurring either free or as a coating on the stone.
c. Gradation requirements of the crushed aggregate shall be as indicated in **Table 2.11**. Sieve analysis shall be determined according to AASHTO T-27.

Table 2.11. GRADATION REQUIREMENTS FOR GRANULAR FILL

Sieve Size	2 ½" - 0	2" - 0	1 ½" - 0	1" - 0	¾" - 0
	Percent Passing				
2 ½"	95 – 100	100			
2"	--	95 – 100	100		
1 ½"	--	--	95 – 100	100	
1 ¼"	55 – 75	--	--	--	
1"	--	55 – 75	--	90 – 100	100
¾"	--	--	55 – 75	--	90 – 100

½"	--	--	--	55 – 75	--
3/8"	--	--	--	--	55 – 75
¼"	30 – 45	30 – 45	35 – 50	40 – 55	40 – 60
U.S. No. 10 sieve	40 – 60	40 – 60	40 – 60	40 – 60	40 – 60

Note: All percentages are by weight. Sieve analysis shall be determined according to AASHTO T 27. The aggregates shall conform to one of the grading requirements of Table 02630-1. Fracture of rounded rock shall be determined according to AASHTO T 335.

2.3.2 Asphaltic Concrete

a. The wearing surface of AC pavement shall conform to ODOT SSC Section 00745, "Hot Mixed Asphalt Concrete" for either Level 2 or Level 3 HMAC, as determined by the City's authorized representative. The base courses for AC pavement shall conform to ODOT SSC Section 00745, "Hot Mixed Asphalt Concrete," for either Level 2 or Level 3 HMAC, as determined by the City's authorized representative.
b. Asphalt cement shall be 85-100 penetration paving asphalt conforming to ASTM D-946.
c. Liquid asphalt for use as a prime coat under AC shall be RC-70 rapid-curing liquid asphalt conforming to AASHTO M-81, or MC-70 medium-curing liquid asphalt conforming to AASHTO M-82.
d. The temperature of the AC during mixing, placement, or while in storage shall not exceed 350°F and shall not be less than 240°F as per ODOT SSC Section 00745.43, "Drying and Heating Aggregates for HMAC." Asphalt storage shall meet requirements of ODOT SSC Section 00745.45, "HMAC Storage."

2.3.3 Portland Cement Concrete

a. PCC for concrete pavement shall be in conformance with Subsection 2.2.6, "Portland Cement Concrete Pavement Design".
b. PCC for curbs, sidewalks, and miscellaneous construction shall be in conformance with Subsection 2.2.6, "Portland Cement Concrete Pavement Design".
c. All forms for curbs and sidewalks shall be 2-inch dimensioned lumber, plywood, or metal forms. Forms on the face of the curb shall have no horizontal form joints within 7 inches of the top of the curb. All forms shall be approved by the City's authorized representative.
d. Reinforcement steel shall conform to ASTM A-615, Grade 40, deformed bars.

2.4 CONSTRUCTION SPECIFICATIONS

2.4.1 General Provisions

The specifications in this chapter and any other applicable requirements of the City shall govern the character and quality of material, equipment, installation, and construction procedures for roadway construction or improvements.

2.4.2 Scheduling

The contractor shall plan their construction work in conformance with Subsection 1.17.2, "Scheduling".

2.4.3 Environmental Protection, Erosion Prevention, and Sediment Control

The contractor shall take all appropriate measures and precautions to minimize their impact on the environment and control erosion, as outlined in Subsection 1.18, "Environmental Protection, Erosion Prevention, and Sediment Control".

2.4.4 Interferences and Obstructions

Various obstructions may be encountered during the course of the work. The contractor shall follow the guidelines established in Subsection 1.17.5, “Interferences, Obstructions, and Abandoned Utilities”.

2.4.5 Contaminated Soil or Hazardous Material

If during construction contaminated soil or with hazardous materials or chemicals are encountered, the Contractor shall follow the procedures specified in Subsection 1.18.2, “Contaminated Soils or Hazardous Materials”.

2.4.6 Trench Excavation, Preparation, and Backfill

Trench excavation, preparation, and backfill shall conform to the requirements of Section 6, “Trench Excavation and Backfill Standards”.

2.4.7 Steel Plates

Where excavated trenches located in the right-of-way are not backfilled at the end of the construction day, the trench shall be covered with Steel Plates. Use of Steel Plates shall conform to “Progress of Construction” as provided in Subsection 1.17.2, “Scheduling”.

2.4.8 Preservation, Restoration, and Cleanup

Cleanup of all construction debris, excess excavation, and excess materials and complete restoration of all fences, mailboxes, ditches, culverts, signposts, and similar items shall be completed according to Subsection 1.17.16, “Preservation, Restoration, and Cleanup”.

2.5 WORKMANSHIP

2.5.1 Demolition

Debris from the demolition of pavement, sidewalks, curbs, or gutters shall be hauled off site and disposed of in a manner approved by the City’s authorized representative.

2.5.2 Clearing and Grubbing

a. Brush shall be cut as near to the ground surface as practicable and removed to a disposal site approved by the City’s authorized representative. Under no condition shall excavated materials be permitted to cover brush before the brush is cleared and disposed of. Ground surface shall be stripped of all organic soil and unsuitable material as recommended in the Geotechnical Report. Stripping operations shall be approved by the City’s authorized representative prior to proceeding with any construction activity.
b. Erosion-prevention and sediment-control measures shall be installed before the start of clearing and grubbing (see Subsection 1.18, “Environmental Protection, Erosion Prevention, and Sediment Control”). The applicant shall call the City's authorized representative for inspection and approval of all erosion-prevention and sediment-control measures before beginning any site clearing, grubbing, or grading.

2.5.3 Subgrade

Subgrade shall be prepared according to the recommendations in the Geotechnical Report and must be approved by the City’s authorized representative. The subgrade shall be compacted to 95% of the maximum dry density, as determined by AASHTO T-180. In periods of dry weather, a proof-roll of the subgrade shall be observed by the City's authorized representative. Soft areas shall be repaired or replaced.

2.5.4 Base and Leveling Course

Base and leveling course shall consist of crushed aggregate as specified in Subsection 2.3.1, "Granular Fill." Base and leveling aggregate material shall be placed and compacted to the required depth of finished pavement and for proper matching with the adjacent existing pavement. Material shall be compacted to 95% of the maximum dry density, as determined by AASHTO T-180. A proof-roll of the base and leveling course shall be observed by the City's authorized representative. Soft areas shall be repaired or replaced.

2.6 CONSTRUCTION PROCEDURE

The geotechnical engineer reserves the right to vary the classes of backfill and the type of resurfacing as best serves the interest of the City, with the approval of the City's authorized representative. Base rock shall be approved by the City's authorized representative prior to placement of asphalt concrete or Portland cement concrete.

A state approved mix design for asphalt concrete or Portland cement concrete shall be submitted to the City's authorized representative for approval a minimum of seven (7) calendar days prior to placement taking place. PCC for concrete pavement, curbs, sidewalks, driveways and miscellaneous construction shall conform to Subsection 2.2.6, "Portland Cement Concrete Pavement Design". Testing shall be in conformance with Subsection 2.6.7, "Testing". Portland cement concrete whose batch time exceeds 90 minutes and has not yet been placed may be refused by the City's authorized representative.

Segmental concrete pavers, bedding sand and joint sand shall conform to Subsection 2.6.4, "Segmental Concrete Pavers"

2.6.1 Curb and Gutter

a. Curb and gutter shall be installed as per City standard detail. At the direction or approval of the City's authorized representative, traffic concrete separator curb shall be installed for certain specific applications.
b. When medians are specified, curb and gutter shall be installed as per City standard detail.
c. At no time shall construction equipment or traffic be allowed on the new curb and gutter until laboratory tests indicate that at least 90% specified design strength has been attained; this includes installation of adjacent asphalt pavement.
d. Root Barriers shall be installed in conformance with Subsection 2.2.27, "Curb and Grading Outside of Street". Generally, the root control system should be installed a minimum of 24 inches deep, with a minimum 20-foot length centered on the root source. Installation of such systems shall be done so as to not disturb the sidewalk, curb or base rock previously installed. Provide landscaping plan showing location of root control barrier system.

2.6.2 Asphalt Pavement

a. After the leveling course is compacted, an asphalt prime coat, specified above, shall be applied to the edges of the existing pavement. Also, curb and gutter, cast iron manhole frames and cleanout frames shall be tack-coated below grade.
b. Asphalt Concrete
    1. **Thickness:** Minimum total thickness of AC shall be in accordance with Subsection 2.2.5, "Asphalt Pavement Design". Place AC after the prime coat has set. If the thickness is six (6) inches or greater, place the asphalt in three lifts. Maximum lift thickness shall be 3 inches. Spread and level the AC with use of a self-propelled machine or hand tools, depending on the area to be paved. Bring the AC to the proper grade and compact by rolling or use hand tampers where rolling is not possible. Temperature of the AC material shall be in conformance with Subsection 2.3.2, "Asphaltic Concrete".

2. **Placement:** Lay the AC mixture in strips of such width as to hold to a practical minimum the number of longitudinal joints required. The longitudinal joints in any layer of pavement shall be offset from those joints in layers below by not less than 6 inches. Joints shall not be located in wheel paths.
3. **Compaction:** Roll with power rollers capable of providing compression of 350 pounds per linear inch. Begin rolling from the outside edge of the replacement and progress toward the existing surfacing, lapping the existing surface at least half the width of the roller. If the existing surfacing bounds both edges of the replacement, begin rolling at the edges of the replacement, lapping the existing surface at least half the width of the roller and progressing toward the center of the replacement area. Overlap each proceeding track by at least half the width of the roller and make sufficient passes over the entire area to produce the desired result. AC pavement shall be compacted to a minimum of 92% relative density, based on the theoretical maximum density determined in accordance with ASTM D-2041, Rice Gravity.
4. **Finished surface:** The finished surface of the new compacted paving shall be flush with the existing surface and shall conform to the grade and crown of the adjacent pavement.

2.6.3 Portland Cement Concrete

a. Construction of PCC pavement shall be in conformance with the guidelines in ODOT SSC Section 00756, "Plain Concrete Pavement."
b. Construction of concrete joints shall follow the guidelines and requirements outlined in the ACPA publication, "Design and Construction of Joints for Concrete Streets," except for the following:
    1. Maximum joint spacing shall be 12 feet.
    2. Transverse joints shall be designed to be skewed 6:1 when meeting the edge of pavement, at the gutter line.
    3. For doweled contraction joints, do not lubricate the dowels.
    4. Staking of curb joints shall be required and performed by or under the direction of a Professional Land Surveyor registered in the State of Oregon.
    5. Isolation joints shall be used around manhole covers. Isolation joints shall be circular with a 3-foot spacing from the manhole cover.
c. All joints shall be sealed in conformance with the ACPA publication, "Design and Construction of Joints for Concrete Streets."
d. The surface finishing and smoothness of PCC surfaces shall follow the guidelines outlined in ODOT SSC Section 00756.49, "Surface Finishing" and Section 00756.55, "Surface Tolerance, Testing, and Correction."
e. At no time shall construction equipment or traffic be allowed on the new pavement until laboratory tests indicate that at least 90% specified design strength has been attained and the City's authorized representative and the design engineer agree that the street is ready for traffic and construction loads.

2.6.4 Segmental Concrete Pavers

Construction of segmental concrete paver streets shall be in accordance with Subsection 2.6.4, "Segmental Concrete Paver Design".

2.6.5 Driveways

a. Construct driveways in accordance with Subsection 2.2.6, "Portland Cement Concrete Pavement Design" and the City standards details.
b. At no time shall construction equipment or traffic be allowed on the new driveway until laboratory tests indicate that at least 90% specified design strength has been attained; this includes installation of adjacent asphalt or concrete pavement.

2.6.6 Sidewalks

a. Construct new sidewalks in conformance with Subsection 2.2.6, "Portland Cement Concrete Pavement Design" and City standard details.
b. Sidewalk repairs, replacement or reconstruction shall be in conformance with Subsection 2.2.6, "Portland Cement Concrete Pavement Design" and City standard details. Finish shall match that of adjacent panels or as directed by City's authorized representative.
c. ADA ramp repairs, replacement or reconstruction shall be in conformance with Subsection 2.2.14, "Intersections" and City standard details.
c. Root Barriers shall be installed in conformance with Subsection 2.2.28, "Sidewalks". Generally, the root control system should be installed a minimum of 24 inches deep, with a minimum 20-foot length centered on the root source. Installation of such systems shall be done so as to not disturb the sidewalk, curb or base rock previously installed. Provide landscaping plan showing location of root control barrier system.

2.6.7 Testing

a. **Asphalt pavement:** asphalt pavement shall have minimum density testing performed every 100 feet of each panel installed. The pavement shall be compacted to a minimum of 92% relative density, based on the theoretical maximum density determined in accordance with ASTM D-2041, "Rice Gravity."
b. **PCC pavement:** Portland cement concrete shall be tested a minimum of once per 4 hours of work or 100 cubic yards of concrete installed. Testing shall include temperature, slump, air content, and minimum of four (4) test cylinders. No water or other additives may be added to the concrete load after testing sample has been taken. The 28-day compressive strength shall meet or exceed 4,350 psi; a minimum compressive strength of 3,915 psi is required to allow traffic on the pavement.
c. **Curb, gutter, and driveways:** Portland cement concrete shall be tested a minimum of once per 4 hours of work. Testing shall include temperature, slump, air content, and minimum of 4 test cylinders. No water or other additives may be added to the concrete load after testing sample has been taken. The 28-day compressive strength shall meet or exceed 3,300 psi. A minimum compressive strength of 2,970 psi is required to allow traffic.
d. **Testing Frequency:** City reserves the right to direct testing agency on frequency of testing.

2.6.8 Weather Conditions

a. AC pavement shall not be placed during periods of rainfall, sand or dust storms, or any imminent storms that might adversely affect the finished pavement quality. AC material shall not be applied over frozen surfaces or standing water. AC shall be placed at temperatures not colder that the minimum atmospheric temperatures specified in **Table 2.12.** Temperature of the AC material shall be in conformance with Subsection 2.3.2, "Asphaltic Concrete".

Table 2.12. ATMOSPHERIC TEMPERATURE REQUIREMENTS

Individual Lift Thickness	Atmospheric Temperature
2" to 2½"	50° F
2½"+ to 3"	40° F

b. PCC pavement shall not be placed during periods of rain or on frozen bases. Placement shall not occur when descending air temperature falls below 40°F, nor shall it resume until ascending air temperature reaches 35°F. The contractor shall protect PCC pavement from weather damage. The contractor shall protect unhardened PCC from precipitation with protective material. If PCC is being placed during cold weather, and the air temperature is

forecast to drop below 35°F, the contractor shall prevent the PCC from freezing for at least 7 days.

2.6.9 Protection of Structures

a. Provide whatever protective coverings may be necessary to keep oil or asphalt from splashing on the exposed parts of bridges, culverts, curbs, gutters, posts, guardrails, road signs, and any other structures during paving operations. Remove any oil, asphalt, dirt, or any other undesirable matter from these structures that resulted from the paving operations.
b. Where water valve boxes, manholes, catch basins, or other underground utility appurtenances are situated in the area to be surfaced, the resurfacing shall be level with the top of the existing finished elevation of the appurtenances. If it is evident that an appurtenance does not match the proposed finished grade, notify the proper authority to have the item altered before proceeding with the resurfacing around the obstruction, unless otherwise approved by the City's authorized representative. Protect all covers during asphalt application.

2.6.10 Excess Materials and Trench Settlement Repair

Contractor shall dispose of excess materials. Contractor shall be responsible for repairing all settlement of pavement over trenches for a 1-year period.

2.6.11 Rock Surfacing

Where gravel shoulders have been disturbed, place ¾"–0" crushed aggregate backfill (see Subsection 2.3.1, "Granular Fill") as surfacing material for the full width of all streets, driveways, parking areas, street shoulders, and other areas disturbed by the construction. Spread the material by "tailgating" and supplement by hand labor when necessary. Level, grade, and compact the aggregate to conform to existing grades and surfaces.

2.7 SURFACE RESTORATION

2.7.1 Scope

This section covers the work necessary for all required replacement of pavement, curbs, sidewalks, rock surfacing, and drainage facilities that were removed during construction. Replacement pavement and base course thickness design shall conform to current City standards.

2.7.2 Asphalt Concrete Replacement

a. Base, sub-base, or subgrade material that has been removed shall be replaced with ¾"–0" crushed aggregate backfill (see Subsection 2.3.1, "Granular Fill") or control density fill (CDF, minimum 28-day compressive strength shall be 200 psi). Bring the trench or excavation to a smooth, even grade at the correct distance below the top of the existing pavement surface so as to provide adequate space for AC pavement. Crushed aggregate trench backfill placed within 3 feet of finished grade shall be compacted to 95% of the maximum dry density, as determined by AASHTO T-180. Crushed aggregate backfill placed below 3 feet of finished grade shall be compacted to 90% of the maximum dry density. Place the leveling course for the full width of the trench where pavement was disturbed, including bituminous surface shoulders.
b. Compact the base rock and leveling course material to 95% of the maximum dry density, as determined by AASHTO T-180. At the conclusion of each day's operation, the contractor shall patch all trench or excavation areas. Cold-patch asphalt mix may be used as a temporary patch.

c. The contractor shall make a 1-foot T-cut in the existing pavement surrounding a trench or excavation. Trim existing pavement to a straight line to remove any pavement that has been damaged or that is broken and unsound to create a smooth, sound edge for joining the new pavement.
d. Within five (5) working days, weather permitting, after completion of all paving or utility work, the contractor shall repair all trench or excavation areas with hot-patch asphalt mix and tack and sand all joints and saw-cuts. AC pavement thickness shall be a minimum of 4 inches or match existing pavement depth, whichever is greater. AC pavement shall be compacted to a minimum of 92% relative density, based on the theoretical maximum density determined in accordance with ASTM D-2041, "Rice Gravity."
    1. When the pavement surface has been cored, the area shall be repaired as follows: At the conclusion of each day's operation, the contractor shall backfill, compact, and patch all cored areas. Cold-patch asphalt mix may be used as a temporary patch.
    2. Within five (5) working days after completion of all paving or utility work, the contractor shall repair all cored areas with hot-patch asphalt mix.

2.7.3 Asphalt Restoration for Streets Listed on 5-Year Moratorium

When emergencies or special circumstances require access to underground utilities, the City may allow street cuts in streets listed on the 5-year moratorium (see Subsection 2.2.34, "Utilities"). In addition to the repair work outlined in Subsection 2.7.2, "Asphalt Concrete Replacement," an additional mill and inlay shall be required over the repaired area to a point 1-foot beyond the T-cut perimeter.

2.7.4 Portland Cement Concrete Replacement

a. **Trenching or Excavation in Pavement and Driveways**: The Public Works Director encourages directional boring under existing concrete streets and discourages trenching or excavation work in streets or driveways. When this is unavoidable, the contractor shall remove and replace all panels that have been cut or damaged within five (5) working days, weather permitting, after completion of all paving or utility work. New panels shall be connected with No. 4 reinforcement tie-bars into the adjacent existing panels. Tie-bars shall be epoxied in place using an epoxy bonding agent as provided in the ODOT QPL. Bring the trench to a smooth, even grade at the correct distance below the top of the existing pavement surface so as to provide adequate space for the base, leveling course, and PCC pavement.
b. **Coring:** When the pavement surface has been cored, the area shall be repaired as follows:
    1. Base or subgrade material that has been removed shall be replaced with ¾"–0" crushed aggregate backfill (see Subsection 2.3.1, "Granular Fill") or CDF. Bring to a smooth, even compacted grade at the correct distance below the top of the existing pavement surface so as to provide adequate space for PCC pavement.
    2. At the conclusion of each day's operation, the contractor shall patch all cored areas within roadways with concrete having a minimum 4,350-psi compressive strength at 28 days (concrete with a minimum 3,300-psi compressive strength may be used in driveways).
c. **Surface Smoothness:** The surface smoothness of the replaced pavement shall be such that when a straightedge is laid across the patched area between the edges of the old surfaces and the surface of the new pavement, the new pavement shall not deviate from the straightedge by more than ¼ inch.
d. **Curbs and Gutters:** Replace concrete curbs and gutters to the same section, width, depth, line, and grade as that removed or damaged. Cut the ends of existing curb to a vertical plane. Before replacing the sections, properly backfill and compact the trench to prevent subsequent settlement.

e. **Catch Basins:** Reinstall catch basins in their original locations and reconnect them to the drainage system in a manner equal to the original. If the existing catch basins are damaged beyond repair by operations, construct new basins of similar size, cross-section, and design as the original.

2.7.5 Sidewalk Replacement

a. Construct sidewalks in accordance with Subsection 2.2.6, "Portland Cement Concrete Pavement Design" and City standard details.
b. Match finish work to existing panels; re-compact base rock if disturbed.
c. Replacement ADA ramps shall meet current standards as per City detail drawings.

2.8 STREET NAMES AND TRAFFIC CONTROL SIGNAGE AND STRIPING

2.8.1 Street Name Signs and Posts

All newly platted streets shall be signed with the name as shown on the approved or proposed county plat; proposed county plats shall show street names as approved by the City. Signs are to conform to City standard details, and as follows.

a. Posts

1. Materials: A minimum of 2 x 2-inch x 10-foot, 14-gauge galvanized "quick-punch" or 12-gauge perforated posts, or approved equal, shall be used. A 2 x 2-inch x 12-foot, 14-gauge galvanized "quick-punch" or 12-gauge perforated posts, or approved equal, shall be used when a combination of signs is more than 36 inches high. Signposts are made of 2-inch square tubing and must be embedded 18 inches into the base.
2. Base: The breakaway post base shall consist of a 2.25 x 2.25-inch (I.D.) x 36-inch galvanized base with a 2.5 x 2.5-inch (I.D.) x 18-inch sleeve placed flush with the base. All sleeves and bases shall be 14-gauge "quick punch" or 12-gauge perforated material, or approved equivalent.
3. Fastening**:** Drive rivets shall be used to fasten signs onto metal signposts, except for street name signs, which shall be attached by hex nuts. Washers shall be used behind all drive rivets used to affix signs to posts. Two drive rivets at right angles shall be used to fasten the post to the base.

b. Street Name Signs

In business districts and on principal arterials, street name signs shall be placed in diagonally opposite corners so that they will be on the right-hand side of the intersection for traffic on the major street. To optimize visibility at signaled intersections, street name signs shall be mounted overhead. In residential districts, two street name signs shall be mounted at each intersection on opposing corners. On T-intersections, the street name signs shall be designated at two locations. One street name sign shall be placed at the end of a T-intersection, and the second placed at the right-hand corner of the intersecting street. Signs naming both streets shall be installed at each street sign location.

1. Materials**:** On streets with a speed limit of 35 mph or greater, a street name sign shall consist of 8-inch-high, flat, 0.080-inch thick aluminum. On streets with speed limits of less than 35 mph, a street name sign shall consist of 6-inch high, flat, 0.080-inch thick aluminum. The minimum length is 24 inches. The maximum length is 36 inches.
2. Sheeting**:** Both sides of street signs shall be coated with green retroreflective sheeting meeting the current MUTCD standards.
3. Lettering**:** Street name signs lettering shall consist of white retroreflective sheeting meeting the current MUTCD standards. Lettering type shall also meet the current MUTCD standards.
4. Private Streets/Drives: Signs for private drives shall meet the requirements listed above with the exception of a background color shall be blue.

2.8.2 Traffic Control Signage and Pavement Marking

Traffic control signing and striping shall be in conformance with the City detail drawings and the current MUTCD. A signage and striping plan shall be included with plan submittals for new street construction and street improvements.

2.9 LIGHTING

All installation of streetlights shall be done in accordance with City requirements and meet AASHTO illumination standards. In addition to these requirements the air gap between the top of pedestal and bottom of light pole shall be grouted with a high-strength, non-shrinking grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout® or approved equal. The warranty for public works projects shall include streetlights.

Street lighting shall be sufficient to provide illumination of the raised median. Streetlights shall also be located as required to provide proper illumination but shall not physically or visually interfere with vehicle or pedestrian traffic.

2.10 STREET ACCEPTANCE POLICY

The City of Molalla will accept new public street installations or systems built to these standards, providing that the following conditions are met.

2.10.1 Legal Recordings

All plats are recorded with the County Surveyor, all easements and dedications are recorded with the County Recorder and the Public Works Department receives a reproducible copy of the recorded documents.

2.10.2 Project Completion

After completion of construction of the total project, and after all testing has been satisfactorily completed, project closeout shall proceed as outlined in Subsection 1.17.17, "Project Closeout."

2.10.3 Maintenance Period

a. The Contractor or Applicant shall be responsible for providing Maintenance Assurance for Public Improvements as outlined in Subsection 1.17.18, "Maintenance Assurance and Warranty." Public street improvements shall be warranted for a minimum of one (1) year; public landscape improvements shall be warranted for a minimum of two (2) years.
b. At any time during the warranty period, the City's authorized representative has reason to believe the public street improvements have defects that were the result of faulty workmanship or flaws in construction material, the responsible party shall be required, at that party's own cost, to repair any faults to the public street improvements deemed necessary by the City's authorized representative.
c. Before the end of the Construction Maintenance period, the City's authorized representative shall inspect the project for any remaining deficiencies. If the deficiencies that remain are determined to be the responsibility of the contractor or the applicant, the contractor or applicant shall then make such repairs.

The Landscape Maintenance assurance shall be released two years after acceptance of construction, providing the landscaping meets the 90% survival level (see Subsection 3.13.2, "Landscape Inspection for Warranty").

SECTION 3 – STORMWATER DESIGN & CONSTRUCTION STANDARDS

3.1 ENGINEERING

3.1.1 Introduction

This section outlines design and construction requirements for stormwater and surface water management. The provisions and technical specifications herein set forth the requirements of the City of Molalla for constructing stormwater and surface water improvements. Interpretations of such provisions and their application in specific circumstances shall be made by the Public Works Department authorized representative. Refer to Section 1 of these standards for general provisions and requirements.

Design guidelines established here are consistent with the City of Molalla Stormwater Master Plan. These provisions are intended to prevent or reduce adverse impacts to the drainage system and water resources of the Willamette River Basin. In combination with other federal, state, and local laws and ordinances, these requirements are intended to protect the beneficial uses of waters in the Willamette River Basin and inside the Molalla city limits.

3.1.2 General Design Requirements

In developing a drainage plan for stormwater management, the design engineer is encouraged to provide, to the extent feasible, on-site stormwater management through the use of Low Impact Development (LID) principles. The primary Stormwater management objective for LID is to match pre-development hydrologic condition over the full range of rainfall intensities and durations. LID principles include, but are not limited to, the following:

1. Integrate Stormwater management into site planning activities.
2. Use natural hydrologic functions as the integrating framework.
3. Minimize site disturbance.
4. Focus on prevention rather than mitigation.
5. Emphasize simple, nonstructural, low-tech, and low-cost methods.
6. Manage stormwater as close to the source as possible.
7. Distribute small-scale LID techniques throughout the landscape.
8. Create a multifunctional landscape.

If approved by the Public Works Department authorized representative, alternative storm water design standards may be substituted for the standards specified herein. While LID principals provide for the consideration of alternative standards that may conflict with the City's adopted Fire Prevention Code, it is understood that alternative standards will be considered and applied on a case-by-case basis.

3.1.3 Alternative Design and Construction Standards

Public storm sewer systems shall be extended to the most distant upstream parcel boundary or boundaries to accommodate current and future storm flows entering the property, unless otherwise approved by the Public Works Department authorized representative. Except as otherwise provided, the extension or upsizing of the public stormwater systems to serve any parcel or tract of land shall be done by, and at the expense of, the property owner or permit applicant. The Public Works Department authorized representative may require a storm pipeline that serves or may serve more than one property to be a public system.

3.1.4 Extension of Public Storm Sewer Systems

Public storm sewer systems shall be extended to the most distant upstream parcel boundary or boundaries to accommodate current and future storm flows entering the property, unless otherwise approved by the Public Works Department authorized representative. Except as

otherwise provided, the extension or upsizing of the public stormwater systems to serve any parcel or tract of land shall be done by, and at the expense of, the property owner or permit applicant. The Public Works Department authorized representative may require a storm pipeline that serves or may serve more than one property to be a public system.

3.1.5 Drainage Plans

a. It is the design engineer's responsibility to ensure that engineering plans are sufficiently clear and concise to construct the project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill the intent of the design guidelines in these standards.
b. All elevation on design plans and record drawings shall be based on the applicable NAVD datum specified in Subsection 1.16.6, "Surveying and Land Monuments."
c. All engineering drainage plans shall be stamped by a Professional Engineer registered in the State of Oregon. The drainage plan shall contain the following:
    1. At least one sheet showing a plan view of the entire project site. If the project site is sufficiently large that detailed drainage plans on any given sheet do not encompass the entire project site, then a sheet showing the plan view of the entire site must serve as an index to subsequent detailed plan sheets.
    2. A topographic map showing existing conditions for the site, including:
        (a) Existing topography for the site.
        (b) Adjacent streets, including street names.
        (c) Existing utilities, including franchised utilities located above or below ground and drainage facilities that transport surface water onto, across, or from the project site. Existing drainage pipes, culverts, and channels shall include the invert elevations.
        (d) Existing sensitive areas (e.g., ravines, swales, steep slopes, wells, springs, wetlands, creeks, lakes). For natural drainage features, show direction of flow, drainage hazard areas, and 100-year floodplain boundary (if applicable).
    3. Plans for proposed drainage improvements shall include the following:
        (a) Finished grades, showing the extent of cut and fill by existing and proposed contours, profiles, or other designations.
        (b) Proposed structures, including roads and road improvements, parking surfaces, building footprints, walkways, landscaped areas, etc.
        (c) Proposed utilities, showing exact line and grade of all proposed utilities at crossings with the proposed drainage system.
        (d) Applicable detail drawings.
        (e) Existing and proposed easements.
        (f) Setbacks from environmentally sensitive areas or protected resource areas.
        (g) Proposed drainage structures, including pipes, open channels, culverts, ponds, vaults, biofiltration swales, infiltration facilities, outfalls, riprap treatment, energy dissipaters, etc.
        (h) Plan and profile of drainage conveyance facilities, including the following information: pipe sizes, pipe types and materials, lengths, slopes, type of structure (e.g. Type CG-30 catch basin), location of structures, invert elevations in/out of structures, and top elevations of structures. Notes shall be included for referencing details, cross-sections, profiles, etc.
        (l) Any proposed phasing of construction. (Note: water quality and quantity facilities must be constructed before completion of any phased construction)
    4. A detailed grading plan shall be provided for all open stormwater quantity or quality control facilities. The plan shall include the following:

(a) Existing ground contours (shaded) and proposed ground contours at a minimum 2-foot contour interval. Slopes steeper than 6H:1V shall be identified.
(b) Location of top and toe of slope.
(c) Limits of embankment designed to impound water.
(d) Location of all drainage structures as well as any other piped utilities in vicinity (0.1-foot detail).
(e) Flow route of the secondary/emergency overflow system (0.1-foot detail).
(f) Maintenance access, as applicable (see Subsection 3.4.4, "Access Road Design").

5. A detailed landscape plan shall be provided for open stormwater quantity or quality control facilities. The plan shall include the following:
   (a) Final ground contours at a minimum 1-foot contour interval.
   (b) Location of top and toe of slope.
   (c) Maximum water surface elevations.
   (d) Location of all drainage structures as well as any other piped utilities in vicinity (screened) (0.1-foot detail).
   (e) Limits of areas to receive amended topsoil.
   (f) Irrigation plan to achieve the required plant survival rate.
   (g) Planting species, locations and densities in accordance with the landscape requirements in Section 8, "Landscape Requirements: Stormwater Quality and Quantity Facilities".
6. Cross-sections shall be provided for at least the following:
   (a) Detention/retention ponds (including parking lot ponds and other multiuse facilities), wet ponds, and sediment ponds. Cross-sections shall graphically illustrate the following:
      (1) Design maximum water surface for the 2-year, 10-year, and 25-year design storms.
      (2) Proposed dead storage water surface (as applicable).
      (3) Pavement section or amended soil section, as applicable.
   (b) Proposed ditches and swales, including vegetated swales.

3.1.6 Storm Systems and Fish Passage

For pipe systems that convey flows from a stream or through sensitive areas, a local representative of ODFW or other applicable state or federal agency shall be contacted to determine whether fish passage is required and to identify site-specific design criteria. All culverts shall be designed for fish passage in accordance with ODFW's *Fish Passage Criteria*, or latest edition, unless exempted by ODFW and the City.

3.1.7 Surveying

a. The design engineer shall be responsible for establishing the location of the sewer using reference stakes offset along the sewer. No construction shall be allowed to begin before construction staking. All staking shall be performed by or under the direction of a Professional Land Surveyor registered in the State of Oregon.

b. Stakes shall locate all public tees, cleanouts, manholes, catch basins, area drains, water quality stations, and pump stations. Maximum spacing for reference stakes is 50 feet. Stakes shall reference cuts or fills to all invert elevations and rim grades. The design engineer shall also be responsible for identifying easements during construction.

3.1.8 Hydrologic Analysis

The hydrologic analysis shall be consistent with Subsection 3.3, "Hydrology and Hydraulics." The design engineer may use various computer models or formulas for the hydrograph analysis, but the Public Works Department authorized representative may verify the design flows and volumes based on King County's SBUH program HYD or as alternatively identified in Subsection 3.2.2, "Hydraulic Design."

3.2 HYDRAULIC ANALYSIS

3.2.1 General

The method of hydraulic calculations shall be subject to approval from the Public Works Department authorized representative and shall be consistent with Subsection 3.3, "Hydrology and Hydraulics."

3.2.2 Hydraulic Design

a. Detention/retention design shall be assessed by dynamic flow routing through the basin. Documentation of the proposed design shall be included in the drainage report. Acceptable analysis programs include:
    1. HYD – King County, Washington
    2. HEC-1 – U.S. Army Corps of Engineers
    3. HEC-HMS – U.S. Army Corps of Engineers
    4. SWMM – U.S. Environmental Protection Agency
    5. HYDRA – Pizer Incorporated
    6. HYDROCAD – HydroCAD Software Solutions
    7. Others, as approved
b. Peak runoff rates shall not exceed predevelopment rates for the specific range of storms. Exemptions to the on-site detention requirements may be considered for situations in which properties discharge directly to the Molalla River or to open bodies of water that have no capacity limitations, or areas where detention in downstream reaches could increase peak stormwater flow rates, and other areas or unique circumstances as identified by the Public Works Director.
c. A pond overflow system shall provide for discharge of the design storm event without overtopping the pond embankment or exceeding the capacity of the emergency spillway. Vortex valve discharge control shall be considered to optimize effective pond volume.
d. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.

3.2.3 Design Criteria

a. The facility can be a combined water quality/quantity facility, provided that it meets all relevant criteria.
b. Interior side slopes up to the maximum water surface = 4H:1V.
c. Maximum exterior side slopes = 2H:1V, unless analyzed for stability by a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering.
d. If slopes need to be mowed, maximum side slope = 4H:1V
e. Walls in Water Quality/Quantity Facilities
    1. Retaining walls may serve as pond walls if the design is prepared and stamped by a Professional Engineer registered in the State of Oregon and a 4-foot tall fence is

provided along the top of the wall. At least 25% of the pond perimeter will be vegetated to a maximum side slope of 3:1.

2. Walls that are 4 feet or higher must meet all of the following criteria:
   (a) Be approved by a Professional Engineer registered in the State of Oregon whose area of expertise is structural or geotechnical engineering.
   (b) The City shall not have maintenance responsibility for the wall. The party responsible for maintenance of the walls within the water quantity tract or easement shall be clearly documented in the City's Stormwater Maintenance Covenant and Access Easement.

f. Over excavate by a minimum of 20% to allow for sediment deposition.
g. Minimum freeboard =1 foot from 25-year design water surface elevation.
h. Maximum water storage depth in water quality/quantity facilities for the 100-year storm event shall not exceed 4 feet in depth, unless otherwise approved by the Public Works Department authorized representative. Where design depth exceeds 4 feet, the facility shall be constructed in conformance with public safety considerations (see Section 3.3.9 "Detention/Retention Facility Protection").
i. Provide approved outlet structure(s) for all flows up to the 100-year storm event.

3.2.4 System Design Criteria

Site development improvement projects shall address on-site and off-site drainage concerns, both upstream and downstream of a project, including but not limited to the following:

a. Modifications to the existing on-site storm drainage facilities shall not restrict flows creating backwater onto off-site property to levels greater than the existing situation, unless approved by the impacted off-site property owners and the Public Works Department authorized representative. The off-site property owner(s) shall agree to and sign a permanent easement legally describing the location of the backwater storage and authorizing the use of their property for stormwater drainage and detention/retention purposes. The easement shall be in a form approved by the City.
b. Storm drainage facilities shall be designed and constructed to accommodate all future full build out flows generated by the proposed development or improvement and all upstream property based on the most recent approved comprehensive land-use plan.
c. The design of storm drainage facilities shall analyze the impact of restrictions downstream of the project site, in accordance with Subsection 3.2.5, "Review of Downstream System." Downstream restrictions that create on-site backwater may be required to be removed by the applicant, at the discretion of the Public Works Department authorized representative, or the on-site backwater shall be addressed in the design of the development's storm system. The removal of downstream obstructions shall not be allowed if removal would create downstream capacity problems.
d. If the projected increase in the surface water runoff from a proposed development will cause or contribute to damage from flooding to existing buildings or dwellings, the downstream stormwater system shall be enlarged to relieve the identified flooding condition before development, or the applicant shall construct an on-site detention/retention facility.

3.2.5 Review of Downstream System

a. The design engineer for each development that establishes or increases the impervious surface area by more than 5,000 square feet shall submit documentation for review and approval by the Public Works Department authorized representative, of the downstream capacity of any existing storm facilities impacted by the proposed development, except for

the construction of a detached single-family dwelling or duplex. The design engineer must perform a two-stage analysis of the drainage system downstream of the development.

1. The analysis shall extend downstream to a point in the drainage system where the additional flow from the proposed development site constitutes 10% or less of the total tributary drainage flow (for example, the analysis point for a 10-acre site would be analyzed to the nearest downstream point with a drainage area of 100 acres).
2. When the additional flow from the proposed development drops to less than 10% of the total tributary drainage flow, the analysis will continue for the lesser of the following:
   (a) One-quarter of a mile; or
   (b) Until the additional flow constitutes less than 5% of the total tributary drainage flow.

b. When the downstream analysis does not continue for at least ¼ mile, the design engineer shall provide a stamped Certification of Investigation stating that he/she has visually investigated the downstream system for at least ¼ mile and is aware of no observable downstream impacts to structures.

3.2.6 Conveyance System Hydraulic Standards

a. The conveyance system shall be designed to convey and contain at least the peak runoff for the 25-year design storm.
b. Structures for proposed pipe systems must be demonstrated to provide a minimum of 1 foot of freeboard between the hydraulic grade line and the top of the structure or finish grade above pipe for the 25-year post-development peak rate of runoff.
c. Design surcharge in new pipe systems shall not be allowed if it will cause flooding in a habitable structure, including below-floor crawl spaces.
d. The 25-year design shall be supplemented with an overland conveyance component demonstrating how a 100-year event will be accommodated. The overland component shall not be allowed to flow through or inundate an existing building.
e. Flows in streets during the 25-year event shall not run deeper than 4 inches against the curb or extend more than 2 feet into the travel lane.
f. Open channel systems shall be designed for minimum 1-foot freeboard from bank full, provided that no structures are impacted by the design water surface elevation.

3.2.7 Catch Basin System Standards

Design of catch basins and drain inlets shall follow the specifications provided in Subsection 3.9.7, “Drain Inlet Design Standards.”

a. **Standard Catch Basin System:** All catch basins shall be sumped. The main storm line shall not pass through any catch basins or sumped manholes unless approved by the Public Works Department authorized representative. No more than three catch basins may be connected in a series before connecting to the main storm line. A ditch inlet or field inlet may be connected directly to the end of the main storm line.
b. **Series Catch Basin System:** Unsumped catch basins are allowed, provided that a sumped manhole is constructed below the unsumped catch basins before the flow enters the main storm line. No more than three unsumped catch basins may be constructed above a water quality or stormwater pretreatment manhole. The main storm line may not pass through the catch basins or sumped manholes. No ditch inlet or field inlet may be part of a series of unsumped catch basins.
c. **Flow-through Catch Basin System:** This system is allowed within an arterial or collector road, provided that the mainline storm pipe has a design velocity of at least 3 feet per second. Unsumped catch basins, ditch inlets, and field inlets are allowed to connect directly

to the main storm line. An adequately sized water quality manhole is required at the downstream end of the flow-through system.

d. Grates shall be identified with a pavement marking, as indicated by the MUTCD, Part 9, or latest edition. Drainage grate inlets shall be bicycle-safe (as required by ORS 810.150) and hydraulically efficient.

3.3 HYDROLOGY & HYDRAULICS

3.3.1 Hydrologic Analysis

This section describes acceptable methods of estimating the quantity and characteristics of surface water runoff, as well as the assumptions and data required as input to the methods. These methods shall be used to analyze existing and to design proposed drainage systems and related facilities.

3.3.2 Rational Method

The rational method for analyzing small drainage basins is allowed, with the following limitations:

a. Use it only in predicting a conservative peak flow rate to be used in determining the required capacity for conveyance elements.

b. Drainage sub-basin area cannot exceed 25 acres for a single calculation without approval from the Public Works Department authorized representative.

c. The time of concentration shall be five minutes when computed to be less than five minutes.

d. Rainfall intensities shall be from **Table 3.1,** or an alternative approved by the Public Works Department authorized representative.

e. Rational formula:

$$Q=C*I*A$$

Where: Q = Flow in cubic feet per second.
C = Runoff coefficient (0.9 for paved surfaces).
I = Intensity.
A = Area in acres

Table 3.1. RAINFALL DISTRIBUTION

Time of Concentration (minutes)	Storm Event (year and probability)					
	2 (50%)	5 (20%)	10 (10%)	25 (4%)	50 (2%)	100 (1%)
0	1.90	2.50	3.00	3.40	4.00	4.50
5	1.90	2.50	3.00	3.40	4.00	4.50
10	1.30	1.70	2.20	2.50	3.00	3.50
15	1.10	1.40	1.80	2.10	2.50	2.90
20	0.90	1.20	1.50	1.80	2.10	2.40
30	0.75	0.95	1.20	1.40	1.65	1.90
40	0.60	0.75	1.00	1.15	1.30	1.60
50	0.55	0.70	0.85	1.00	1.15	1.35
70	0.45	0.55	0.70	0.82	0.95	1.10
100	0.40	0.45	0.55	0.67	0.75	0.90

180 or more	0.35	0.40	0.50	0.60	0.70	0.85

1. Data for east Washington County; data from Clean Water Services.

3.3.3 Unit Hydrograph Method

a. **Hydrograph Analysis:** To obtain a realistic and consistent hydrologic analysis for each development site, all developments shall use the hydrograph analysis method for drainage planning and design unless otherwise approved in advance by the Public Works Department authorized representative. The physical characteristics of the site and the design storm shall be used to determine the magnitude, volume, and duration of the runoff hydrograph. The Santa Barbara Urban Hydrograph (SBUH) will be the primary acceptable unit hydrograph method.
The HYD computer program, developed by King County, Washington, in its "Surface Water Design Manual," January 1990, uses these methods to generate, add, and route hydrographs. The Public Works Department authorized representative may check all hydrologic calculations using the King County HYD program. However, the City will allow the use of the rational method for analysis of drainage basins of 25 acres or less.

b. **Design Storm:** Return frequency and duration specify the design storm event. The design storms shall be based on two parameters:
   1. Total rainfall (depth in inches).
   2. Rainfall distribution (dimensionless).

c. **Design Storm Distribution:** The total depth of rainfall for storms of 24-hour duration is shown in **Table 3.2 The** rainfall distribution to be used in the City is the design storm of 24-hour duration based on the standard National Resource Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), type 1A rainfall distribution using **Table 3.3**.

Table 3.2. RAINFALL DISTRIBUTION

Recurrence Interval (years)	Total Precipitation Depth (inches)
2	2.50
5	3.10
10	3.45
25	3.90
50	4.20
100	4.50

Table 3.3. DESIGN STORM DISTRIBUTION CHART[1]

Hour	Percent Rainfall		Rainfall Depth (inches)					
			2-Year Storm	5-Year Storm	10-Year Storm	25-Year Storm	50-Year Storm	100-Year Storm
	Incremental	Cumulative	2.50	3.10	3.45	3.90	4.20	4.50
1	2.40	2.40	0.06	0.07	0.08	0.09	0.10	0.11
2	2.60	5.00	0.07	0.08	0.09	0.10	0.11	0.12
3	3.20	8.20	0.08	0.10	0.11	0.12	0.13	0.14
4	3.80	12.00	0.10	0.12	0.13	0.15	0.16	0.17
5	4.44	16.44	0.11	0.14	0.15	0.17	0.19	0.20
6	5.18	21.62	0.13	0.16	0.18	0.20	0.22	0.23
7	6.48	28.10	0.16	0.20	0.22	0.25	0.27	0.29
8	16.44	44.54	0.41	0.51	0.57	0.64	0.69	0.74
9	7.58	52.12	0.19	0.23	0.26	0.30	0.32	0.34
10	5.28	57.40	0.13	0.16	0.18	0.21	0.22	0.24
11	4.96	62.36	0.12	0.15	0.17	0.19	0.21	0.22
12	4.32	66.68	0.11	0.13	0.15	0.17	0.18	0.19
13	4.02	70.70	0.10	0.12	0.14	0.16	0.17	0.18
14	3.42	74.12	0.09	0.11	0.12	0.13	0.14	0.15
15	3.28	77.40	0.08	0.10	0.11	0.13	0.14	0.15
16	3.00	80.40	0.08	0.09	0.10	0.12	0.13	0.14
17	2.80	83.20	0.07	0.09	0.10	0.11	0.12	0.13
18	2.40	85.60	0.06	0.07	0.08	0.09	0.10	0.11
19	2.40	88.00	0.06	0.07	0.08	0.09	0.10	0.11
20	2.40	90.40	0.06	0.07	0.08	0.09	0.10	0.11
21	2.40	92.80	0.06	0.07	0.08	0.09	0.40	0.11
22	2.40	95.20	0.06	0.07	0.08	0.09	0.10	0.11
23	2.40	97.60	0.06	0.07	0.08	0.09	0.10	0.11
24	2.40	100.00	0.06	0.07	0.08	0.09	0.10	0.11

1. Source: *Sub-basin Hydrologic Modeling Criteria*, Kramer, Chin, & Mayo, Inc. 1991.

d. **Runoff Parameters:** The physical drainage basin characteristics listed below shall be used to develop the runoff hydrograph.

1. **Area**

(a) To obtain the highest degree of accuracy in hydrograph analysis requires the proper selection of homogeneous basin areas. Significant differences in land use in a given basin must be addressed by dividing the basin area into sub-basin areas of similar land use or runoff characteristics. Hydrographs shall be computed for each sub-basin area and superimposed to form the total runoff hydrograph for the basin.

(b) All pervious and impervious areas within a given basin or sub-basin shall be analyzed separately. This may be done by either computing separate hydrographs or computing the precipitation excess. The total precipitation excess is then used to develop the runoff hydrograph. By analyzing pervious and impervious areas separately, the cumulative errors associated with averaging these areas are avoided, and the true shape of the runoff hydrograph is better approximated.

2. **Selection of Curve Number**
   (a) The NRCS has developed CN values based on soil type and land use. The combination of these two factors is called the "soil-cover complex."
   (b) Soil-cover complexes have been assigned to one of four hydrologic soil groups, according to their runoff characteristics. Soil hydrologic groups may be found in Table 14, *Soil Survey of Clackamas County, Oregon* (SCS, November 1985) or Table 13, *Soil Survey of Washington County*, Oregon (SCS July 1982).
      (1) Many factors can affect the CN value for a given land use. For example, the movement of heavy equipment over bare ground may compact the soil so that it has a lower infiltration rate and greater runoff potential.
      (2) CN values can be area-weighted when they apply to pervious areas of similar CN (within 20 CN points). However, high CN areas shall not be combined with low CN areas (unless the low CN areas are less than 15% of the sub-basin).
      (3) Antecedent soil moisture values shall be considered. Soil shall be considered to be saturated before the start of a precipitation event.

3. **NRCS Curve Number Equations:**
   (a) The rainfall-runoff equations of the NRCS curve number method relate a land area's runoff depth (precipitation excess) to the precipitation it receives and to its natural storage capacity, as follows:

$$Q_d = (P_R - 0.2S)^2 / (P_R + 0.8S), \text{ for } P_R > 0.2S$$

and

$$Q_d = 0, \text{ for } P_R < 0.2S$$

Where: Q_d = runoff depth in inches over the area.
P_R = precipitation depth in inches over the area.
S = potential maximum natural detention/retention, in inches over the area, due to infiltration, storage, etc.

The area's potential maximum detention/retention, S, is related to its curve number, CN:

$$S = (1000/CN) - 10$$

The computed runoff represents inches over the tributary area. Therefore, the total volume of runoff is found by multiplying Q_d by the area (with necessary conversions):

Total runoff volume (cf) = Q_d (in) $\times$ A (ac) x 3,630 (ft^3/(ac-in))

   (b) **Time of Concentration:** Time of concentration (T_c) is the time for runoff to travel from the hydraulically most distant point of the watershed to the point where the hydrograph is to be calculated. Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of T_c. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system. T_c influences the shape and peak of the runoff hydrograph.
      (1) **Sheet Flow:** Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. For sheet flow up to 300 feet, use the kinematics solution below to directly compute T_t:

$$T_t = (0.93L^{0.6} \times n^{0.3}) / (I^{0.4} \times S^{0.3})$$

Where: T_t = travel time (minutes).

n = Manning's effective roughness coefficient for sheet flow.
L = flow length (feet).
I = rainfall intensity (inches per hour).
S = slope of hydraulic grade line (feet per foot [ft./ft.])

Sheet flow shall not be used for distances over 300 feet.

(2) **Shallow Concentrated Flow:** For slopes less than 0.005 ft./ft. (0.5%), the following equations can be used:
   (a) For unpaved surfaces: $V=16.1345\ (S)^{0.5}$
   (b) For paved surfaces: $V=20.3282\ (S)^{0.5}$

   Where: V = velocity (feet per second).
   S = slope (ft./ft.).

(3) **Channel Flow:** A commonly used method of computing average velocity of flow, once it has measurable depth, is the following equation:

$$V = (1.486 / n) \times R^{0.6} \times S^{0.5}$$

Where: V = velocity (ft./s).
n = Manning's roughness coefficient.
S = slope of flow path (ft./ft.).
R = area/perimeter.

3.3.4 Water Quality Volume and Flow

The water quality storm is the storm required by regulations to be treated. The storm defines both the volume and rate of runoff.

a. Water Quality Storm**:** Total precipitation of 0.36 inches falling in four hours, with a storm return period of 96 hours.
b. Water Quality Volume (WQV**)** is the volume of water that is produced by the water quality storm. WQV is equal to 0.36 inches of rainfall over 100% of the new impervious area:

$$\text{Water quality volume (cf)} = \frac{0.36(\text{in}) \times \text{area (sf)}}{12\ (\text{in./ft.})}$$

c. Water Quality Flow (WQF**)** is the average design flow anticipated from the water quality storm:

$$\text{Water quality flow (cfs)} = \frac{\text{Water quality volume (cf)}}{14{,}400\ \text{sec}}$$

or

$$\text{Water quality flow (cfs)} = \frac{0.36(\text{in}) \times \text{area (sf)}}{12(\text{in/ft.})(4\ \text{hr.})(60\ \text{min/hr.})(60\ \text{sec/min})}$$

3.3.5 Hydraulics

Catch Basins and inlets collect water from an adjacent ditch, gutter line, or pavement and convey the water to a storm sewer or culvert. The inlet systems are to be designed in accordance with the following criteria:

a. Subsection 3.9.7, "Drain Inlet Design Standards."
b. The following sources shall be used to locate catch basins and inlets:
   1. ODOT's "Hydraulics Manual."
   2. Hydraulic Engineering Circular 12 (Federal Highway Administration, FHWA-84-202), "Drainage of Highway Pavements."

3.3.6 Area Drains

The maximum acceptable intake flow rate for Type II area drains and ditch inlets is shown in **Table 3.4**.

Table 3.4. INTAKE FLOW RATE, GRATE ANGLE 30 DEGREES

Hydraulic Head (ft.)[1]	0.5	1.0	1.5	2.0	2.5	3.0	40.	5.0	7.0	10.0
Flow Rate (cfs)[2]	2.0	5.6	10.3	11.9	13.3	14.6	16.8	18.8	22.3	26.6

[1]Measured from bottom of grate to headwater.
[2]Cubic feet per second.

3.3.7 Channel Protection

Open channels shall be designed to prevent long-term scouring of the channel. Where rip rap protection is specified, rip rap protection shall be placed over a filter fabric base or a minimum 6-inch thick gravel base. **Table 3.5** provides additional design guidance for the design engineer; however, the design engineer is, as always, responsible for the final design.

Table 3.5. CHANNEL PROTECTION, NEW CHANNEL CONSTRUCTION

Velocity at Design Flow (feet per second)		Required Protection	Thickness (feet)	Minimum Height Above Design Water Surface (feet)
Greater Than	Less Than or Equal to			
0	5	Vegetation lining	N/A	0.5
5	8	Bioengineered lining[1] or ODOT Class 50 riprap[2]	N/A 1.5	1
8	12	ODOT Class 200 riprap[2]	2.5	2
12	20	Slope mattress, etc.[3]	Varies	2

[1]Bioengineered lining allowed for flows between 5 and 8 feet per second.
[2]ODOT riprap class in English units
[3]For high-velocity channels, engineering calculations are to be submitted to the Public Works Department authorized representative for review and approval.

3.3.8 Outfall Protection

Storm system outfalls shall be designed to prevent scouring at, or in association with, the outfall discharge and provide velocity reduction before discharge to the receiving channel. Engineered energy-dissipaters shall be required for outfalls with design flow discharge velocities greater than 3 feet per second (fps). **Table 3.6** provides design guidance for the design engineer; however, the design engineer is, as always, responsible for the final design.

Table 3.6. ROCK PROTECTION

Discharge Velocity at Design Flow (fps)	Required Protection (Minimum Dimension)				
	Type	Thickness[2]	Width	Length	Height
0 to 5	ODOT Class 50 riprap[1]	1.5 ft.	Diameter + 6 ft.	8 ft. or 4 x diameter, whichever greater	Crown + 1 ft.

5 to 10	ODOT Class 200 riprap[1]	2.5 ft.	Diameter + 6 ft. or 3 x diameter, whichever greater	12 ft. or 4 x diameter, whichever greater	Crown + 1 ft.
Greater than 10	Designed system[3]	As required	As required	As required	Crown + 1 ft.

[1]ODOT riprap class in English units.

[2]Riprap shall be grouted in place.

[3]For high-velocity outfalls, engineering calculations are to be submitted to the Public Works Department authorized representative for review and approval.

3.3.9 Detention/Retention Facility Protection

a. Stormwater quantity detention/retention facilities and stormwater quality facilities shall be designed to prevent scouring at the inflow structure(s) by use of an engineered energy-dissipating device such as a Swale Inflow Spreader or other method approved by the Public Works Department authorized representative.
b. The nearest upstream manhole from a stormwater quantity detention/retention pond or swale shall be a stormwater pretreatment manhole conforming to these standards.
c. Safety
    1. Stormwater facilities shall include a vegetated buffer or a safety bench.
    2. Side slopes in stormwater facilities shall not exceed 4H:1V up to the maximum design water elevation.
    3. Stormwater facilities shall be posted with warning signs that prohibit swimming or wading.
    4. Where fencing is required by federal, state, and local laws and ordinances for public safety considerations or security reasons, the fencing shall be aesthetically designed. No barbed wire fencing shall be used.

3.3.10 Drainage Report

a. The drainage report shall be on 8½-by-11 paper. Maps shall be folded to 8½-by-11 size unless another format is approved before the report is submitted.
b. The drainage report shall be prepared by and bear the seal and original signature of a Professional Engineer registered in the State of Oregon and shall contain the following information:
    1. Cover sheet, including the project name, applicant's name, address, and telephone number, design engineer's name, and date of submittal.
    2. Table of contents, with page numbers for each section of the report, including exhibits, appendices, and attachments.
    3. Vicinity Map.
    4. Project description, specifying type of permit(s) for which the applicant is applying, size and location of the project site, address or parcel number, legal description of the property, and property zoning. Also describe other permits required (e.g., Corps of Engineers 404 fill permit). Describe the project, including proposed land use, proposed site improvements, proposed construction of impervious surfaces, proposed landscaping, and special circumstances.
    5. Existing Conditions
        (a) Describe existing site conditions and relevant hydrological conditions, including but not limited to the following:
            (1) Project site topography.
            (2) Land cover and land use.
            (3) Abutting property land cover, land use, and ownership information.

(4) Off-site drainage to the property.
(5) Natural and constructed channels.
(6) Wetlands, creeks, ravines, gullies, steep slopes, springs, and other sensitive areas on or adjacent to the project site.

(b) General soil conditions in the project site, using SCS soil designations.
(c) Points of discharge for existing drainage from the project site.
(d) References to relevant reports, such as basin plans, flood studies, groundwater studies, wetland designations, watershed plans, sub-basin master plans, sensitive area designation, environmental assessments, water quality reports, or other relevant documents. Where such reports impose additional conditions on the applicant, those conditions shall be included in the report.
(e) Soils report(s), where applicable.
(f) Hydrologic analysis, pursuant to Subsection 3.3.1, "Hydrologic Analysis."
(g) Basin map(s), showing boundaries of project, any off-site contributing drainage basins, on-site drainage basins, approximate locations of all major drainage structures in the basins, and depicting the course of stormwater originating from the subject property and extending to the closest receiving body of water. Reference the source of the topographic base map (e.g., USGS), the scale of the map, and include a north arrow.
(h) Description of drainage basin(s) to which the project site contributes runoff, and identification of the receiving waters for each basin.

6. Developed Conditions
   (a) Developed site drainage conditions: Describe the land cover resulting from the proposed project; describe the potential stormwater quantity and quality impacts resulting from the proposed project; describe the proposed methods for collection and conveyance of runoff from the project site, for the control of any increase in stormwater quantity resulting from the development, and for maintaining stormwater quality.
   (b) Description of upstream and downstream basins, identifying any sources of runoff to the project site. Description shall be based on field investigation. Any existing drainage or erosion issues upstream that may affect the proposed development shall be noted.
   (c) Downstream analysis.
   (d) Hydraulic design computations, supporting the design of all proposed stormwater conveyance, quantity and quality control facilities, and verifying the capacity of existing and proposed drainage facilities. These computations may include capacity and backwater analysis required either as part of the proposed drainage design or as part of the downstream drainage investigation, and flood routing computations required for the design of detention/retention storage facilities, for wetland impact analysis, or for floodplain analysis. Include a description of how the stormwater system will function during the water quality storm, 2-year storm, 10-year storm, 25-year storm, and 100-year storm.
   (e) Operation and maintenance manual required for privately owned and maintained stormwater quantity and quality control facilities. The manual will be an attachment to the City's Stormwater Maintenance Covenant and Access Easement.
   (f) Appendices shall include necessary technical information.

3.4 WATER QUANTITY FACILITY DESIGN

3.4.1 Mitigation Requirement for Quantity

Each new development is responsible for mitigating its impacts on the public stormwater system. The Public Works Department authorized representative shall determine which of the following techniques may be used to satisfy this requirement. Mitigation requirements shall meet applicable federal, state, and local standards and regulations.

a. Construction of permanent on-site stormwater quantity detention/retention facilities, designed in accordance with Subsection 3.5, "Water Quality Facility Design."
b. Enlargement or improvement of the downstream conveyance system shall be done in accordance with Subsection 3.5, "Water Quality Facility Design."

3.4.2 Criteria for Requiring On-Site Detention/Retention

On-site facilities shall be constructed when any of the following conditions exist:

a. The proposed development establishes or increases the impervious surface area by more than 5,000 square feet. Development includes new development, redevelopment, and/or partial redevelopment.
b. There is an identified downstream deficiency, and detention/retention rather than conveyance system enlargement is determined to be the more effective solution.
c. There is an identified regional detention/retention site within the boundary of the development.
d. A site within the boundary of the development would qualify as a regional detention/retention site under the criteria or capital plan adopted by the City.
e. Water quantity facilities are required by City-adopted stormwater master plans or adopted sub-basin master plans.

3.4.3 Water Quantity Facility Design Standards *(Revised 06/17/20)*

a. When required, stormwater quantity on-site detention/retention facilities shall be designed to capture runoff so the post-development runoff rates from the site do not exceed the predeveloped (see Definitions) runoff rates, based on a 2- through 25-year, 24-hour return storm. Specifically, the 2-, 10-, and 25-year post-development runoff rates shall not exceed their respective 2-, 10-, and 25-year predevelopment runoff rates; unless other criteria are identified in an adopted stormwater master plan or sub-basin master plan.
b. Water quantity facilities shall be designed to include inlet energy dissipation and a sediment forebay. The sediment forebay shall consist of an area in which heavier sediments can accumulate and receive periodic maintenance to remove these sediments. The forebay size shall be engineered with respect to the anticipated flow rate, and have a durable surface, such as concrete or rock, suitable for periodic maintenance. A minimum size of 20 square feet of water area is anticipated. Some type of barrier shall separate the forebay area from the main area of the water quantity facility. The invert of the incoming storm drain pipe shall be set at or above the top of the forebay barrier elevation and shall consider the pipe wall thickness. Pond inlets with a drainage area of less than one third-acre (⅓ AC) may not require a sediment forebay.
c. Water quantity facilities shall be designed to allow for proper functioning with full sediment accumulation as allowed in Subsection 3.6.6, "Sediment Management/Pollutant Control"
d. When required because of an identified downstream deficiency, stormwater quantity on-site detention/retention facilities shall be designed so the peak runoff rates will not exceed predevelopment rates for the range of storms that cause the downstream deficiency.
e. The average, wet-season groundwater elevation shall be determined for the proposed stormwater quantity facility. Groundwater elevation may be established through

measurements at existing wells, installation of piezometer(s), or other methods approved by the Public Works Department authorized representative. The facility shall be designed to exclude detention/retention capacity below the established wet-season groundwater elevation.

f. Water quantity facilities in which water is in direct contact with the soil must be lined with either a low permeability liner or a treatment liner when the soil does not have properties which reduce the risk of groundwater contamination from stormwater runoff that may infiltrate in the facility. Liners shall be designed in accordance with Section 11, "Water Quality Facility Liners."
g. Construction of on-site detention/retention facility shall not be allowed as an option if such a facility would have an adverse effect on receiving waters in the basin or sub-basin in the event of flooding or would increase the chance or severity of flooding problems downstream of the site.
h. No water quantity facility shall be built in a public easement or right-of-way unless approved by the Public Works Department authorized representative or be located in an area designed or used for vehicular parking.
i. Vegetation shall be planted in accordance with Section 8, "Landscape Requirements for Stormwater Facilities."
j. Water Quantity Facilities shall be constructed in conformance with Subsection 3.2.3, "Design Criteria."
k. Water Quantity Facilities shall be constructed in conformance with public safety considerations in "Safety" in Subsection 3.3.9, "Detention/Retention Facility Protection."
l. Stormwater quantity facilities shall be protected in conformance with Subsection 3.3.9, "Detention/Retention Facility Protection."
m. Access roads to stormwater facilities shall be in conformance with Subsection 3.4.4, "Access Road Design."

3.4.4 Access Road Design

Access roads are for maintenance and inspection purposes. All-weather access shall be provided for the entire perimeter of the stormwater facility, unless otherwise approved by the Public Works Department authorized representative. At a minimum, access shall be provided for maintenance and inspection of the inflow and outflow structures of the facility. The following criteria are the minimum City requirements:

a. Three inches of Class C AC; over 8 inches of ¾"-0"compacted crushed aggregate; over firm subgrade. Crushed aggregate and subgrade shall be compacted to 95% of maximum dry density, as determined by AASHTO T-180.
   Or
   The design engineer may submit a certified road design capable of supporting a 30-ton maintenance vehicle in all weather conditions.
b. The plan shall include design of strengthened sidewalk sections where maintenance vehicles will cross.
c. Maximum grade: 15% with a maximum 3% cross-slope.
d. Minimum width: 15 feet on straight runs and curves. Curves shall be designed with a minimum 40-foot interior radius.
e. A 2-foot wide gravel shoulder shall be provided on the facility side of the access road.
f. Access shall extend to within 10 feet of all control structures, unless otherwise approved by the Public Works Department authorized representative.
g. If fencing is required for public safety or security reasons, the fence shall include a 12-foot-wide lockable gate for maintenance access.

3.4.5 Flood Management Design Standards

a. **Purpose:** The purpose of these standards is to reduce the risk of flooding, prevent or reduce the risk to human life and property, and maintain the functions and values of floodplains, such as allowing for the storage and conveyance of stream flows through existing and natural flood conveyance systems.

b. **Flood Management Areas Defined:** Flood management areas shall include, but are not limited to, the following:
   1. Land identified within the 100-year floodplain and floodway, as shown on the Federal Emergency Management Agency (FEMA) flood insurance maps.
   2. Land identified in updated flood studies or any other authoritative data documenting flood elevations, as approved by the City. The design engineer shall use the most recent and technically accurate information available to determine flood areas.

c. **Flood Plain Delineation:** In areas of the City where the 100-yr flood plain has not been defined as per this section, the Public Works Director may require a study to delineate the 100-yr flood plain prior to development of a site to access the potential impact to upstream or downstream properties.

d. **Design Criteria:** Design and construction of improvements within the 100-yr flood plain shall be in conformance with these Standards, all flood plain requirements of the Molalla City Code, and all applicable federal, state, and local statutes and rules governing floodplains and flood hazard areas.
   1. All fill placed in a floodplain shall be balanced with an equal amount of removed soil material and shall not decrease the floodplain storage capacity at any stage of a flood (2-, 10-, 25-, or 100-year event). No net fill in any floodplain is allowed except when *all* of the following conditions are met:
      (a) When an area has received special protection from floodplain improvement projects that lower the floodplain or otherwise protect affected properties.
      (b) Where the exceptions comply with adopted master plans, watershed management plans, or sub-basin plans, if any.
      (c) When all required permits and approvals have been obtained in compliance with FEMA rules and other local, state, and federal laws regarding fill in floodplains.
   2. Large areas may not be excavated to gain a small amount of fill in a floodplain. Excavation areas shall not exceed the fill areas by more than 50% of the square footage, unless approved by the Public Works Department authorized representative.
   3. Any excavation dug below the winter low-water elevation shall not count toward compensating for fill, because those areas would be full of water in the winter and not available to hold stormwater after a rain. Winter low-water elevation is defined as the water surface elevation during the winter when it has not rained for at least three days, and the flows resulting from storms have receded. The elevation can be determined from records, studies, or field observation. Any fill placed above the 100-year floodplain will not count toward the fill volume.
   4. The excavated area must be designed to drain if it is an area identified to be dry in the summer, e.g., if it is used for a park or mowed in the summer. Excavated areas identified to remain wet in the summer, such as a constructed wetland, shall be designed not to drain. For areas that are to drain, the lowest elevation shall be at least 6 inches above the winter low-water elevation and sloped to drain. Slopes of 1% will be allowed in areas of less than 1,000 square feet.
   5. Excavation to balance a fill shall be on the same parcel as the fill unless it is not reasonable or practicable to do so. In such cases, the excavation shall be in the same drainage basin, within points of constriction on the conveyance system, if any, as near

as practical to the fill site, and shall be constructed as a part of the same development project.

6. Temporary fills permitted during construction shall be removed at the completion of construction and before the close of the in-stream work window, as defined by the ODFW or federal, state, or other local authority.
7. Excavation and fill required for the construction of detention/retention facilities or other facilities, such as levees, shall be specifically designed to reduce or mitigate flood impacts. Levees shall not be used to create vacant buildable land.
8. Excavation and fill required to restore or enhance floodplains, riparian areas, wetlands, uplands, and streams, including but not limited to the planting of vegetation and daylighting of existing storm pipes, shall be permitted as long as the design complies with applicable federal, state, and local standards.
9. The floodplain may not be modified to increase water velocities such that stream bank erosion will be increased, unless the stream banks are protected to prevent the increased erosion.
10. Uncontained areas of hazardous materials, as defined by the Oregon DEQ, are prohibited in flood management areas.
11. Any proposed work within, or modification to, a floodway must be certified by a Professional Engineer registered in the State of Oregon as to how it conforms to these standards and FEMA regulations.
12. For streams, creeks, rivers, and other watercourses where the floodway has not been identified, the entire floodplain shall be treated as a floodway unless a study has been prepared by a Professional Engineer registered in the State of Oregon and approved by the Public Works Department authorized representative to define the floodway limits for a stream section.

3.5 WATER QUALITY FACILITY DESIGN

This section describes methods of designing water quality facilities. Water quality facilities are designed to remove pollutants from stormwater runoff. The pollutants of concern include, but are not limited to, sand, silt, and other suspended solids; metals such as copper, lead, and zinc; nutrients such as nitrogen and phosphorus; certain bacteria and viruses; and organics such as oil, grease, petroleum hydrocarbons, and pesticides. Methods of removing pollutants include sedimentation or settling, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Floatable pollutants such as oil, debris, and scum can be removed with separators.

3.5.1 Water Quality Facility Design Standards

a. Purpose: New development and other activities that create new impervious surfaces or increase the amount of stormwater runoff or pollution leaving the site are required to construct or fund permanent water quality facilities to reduce contaminants entering the stormwater and surface water system. Water quality volume and flow shall be determined as described in Subsection 3.3.4, “Water Quality Volume and Flow.”
b. Criteria for requiring construction of water quality facility
   A water quality facility shall be constructed on site unless, in the judgment of the Public Works Department authorized representative, any of the following conditions exist:
   1. The site location, size, gradient, topography, soils, or presence of a significant resource make it impractical or ineffective to construct an on-site facility.
   2. The sub-basin has a more effective, existing regional site designed to incorporate the development or which has the capacity to treat the site stormwater.

3. The development is for construction of one- or two-family (duplex) dwellings on existing lots of record which will establish or create less than 5,000 square feet of impervious surface.

c. Design standards
   1. Stormwater quality facilities shall be designed to capture and treat 80% of the average annual runoff volume, to the maximum extent possible, with the goal of 70% total suspended solids (TSS) removal. Impervious surfaces shall include pavement, gravel roads, buildings, public and private roadways, and all other surfaces with similar runoff characteristics.
   2. The removal efficiency standard for TSS specifies only the design requirements. It is not intended as a basis for performance evaluation or compliance determination of a stormwater quality control facility installed or constructed pursuant to this section.
   3. If an on-site water quality facility cannot be constructed to treat the runoff from the development's impervious surface, then with the approval of the Public Works Department authorized representative, an on- or off-site water quality facility may be designed to treat runoff from an equivalent area of adjacent untreated impervious surfaces. The water quality facility shall meet all applicable requirements of these standards.
   4. Water quality facilities shall be designed for a dry weather storm event totaling 0.36 inches of precipitation falling in four hours, with an average storm return period of 96 hours.
   5. Water quality facilities shall be sized for impervious area, as outlined below in "Impervious Area Used in Design".
   6. Water quality facilities shall be designed to include inlet energy dissipation and a sediment forebay in conformance to Subsection 3.4.3, "Water Quantity Facility Design Standards."
   7. Water quality facilities shall be designed to allow for proper functioning with full sediment accumulation as allowed in Subsection 3.6.6, "Sediment Management/Pollutant Control."
   8. Water quality facilities shall be constructed as part of the development's public improvements.
   9. Other design options for meeting the requirements of this section may be considered by the Public Works Department authorized representative for approval, as referenced in Subsection 3.1.3, "Alternative Design and Construction Standards."
   10. Water quality facilities in which water is in direct contact with the soil must be lined with either a low permeability liner or a treatment liner when the soil does not have properties which reduce the risk of groundwater contamination from stormwater runoff that may infiltrate in the facility. Liners shall be designed in accordance with Section 11, "Stormwater Quality Facility Liners."
   11. Water Quantity Facilities shall be constructed in conformance with Subsection 3.2.3, "Design Criteria."
   12. Stormwater quality facilities shall be protected in conformance with Subsection 3.3.9, "Detention/Retention Facility Protection."

d. Impervious Area Used in Design
   1. Water quality facilities are required when proposed development establishes or increases the impervious surface area by more than 5,000 square feet. Development includes new development, redevelopment, and/or partial redevelopment.
   2. For single-family and duplex residential subdivisions, water quality facilities shall be sized for all impervious areas created by the subdivision, including all residences on

individual lots at the current rate of 2,750 square feet of impervious surface area per dwelling unit.

3. For all developments other than single-family and duplex dwellings, including row-houses and condominiums, the sizing of water quality facilities shall be based on the impervious area to be created by the development, including structures and all roads and impervious areas. Impervious surfaces shall be based on building permits, construction plans, or other appropriate methods of measurement deemed reliable by the Public Works Department authorized representative.
4. The City encourages design initiatives that reduce the effective impervious area. For developments other than single-family and duplex dwellings, a smaller water quality facility may be possible.

3.5.2 General Requirements

a. No water quality facility shall be built in a public easement or right-of-way, unless approved by the Public Works Department authorized representative.
b. Vegetation shall be planted in accordance with Section 8, "Landscape Requirements for Stormwater Facilities."
c. Safety of stormwater quality facilities shall be in conformance with Subsection 3.3.9, "Detention/Retention Facility Protection."

3.5.3 Access Road

Access roads to stormwater quality facilities shall be in conformance with Subsection 3.4.4, "Access Road Design."

3.5.4 Water Quality Treatment Methods

Methods used for water quality treatment facilities form several general categories:

a. **Pretreatment Devices:** Pretreatment often must be provided for filtration and infiltration facilities to protect them from clogging or to protect groundwater. Appropriate pretreatment devices include a pre-settling basin, wet pond or vault, water quality manhole, or oil/water separator.
b. **Filtration:** Filtration entails capturing and temporarily storing stormwater and then passing it through a filter bed of sand, organic matter, soil, or other acceptable treatment media. Specific media such as activated carbon or zeolite can remove hydrocarbons and soluble metals.
c. **Ponds:** Ponds treat stormwater by settling particulates during quiescent conditions (sedimentation), by biological uptake, and by vegetative filtration. Ponds may be single-purpose facilities, providing only stormwater treatment, or they may be combined with a detention pond or vault to also control flow.
d. **Wetlands:** Constructed wetlands, like natural wetlands, remove pollutants through sedimentation, filtration, and biologic processes. Wetlands typically have shallower water than ponds. They may also incorporate small permanent pools and extended detention storage.
e. **Infiltration:** Infiltration refers to the use of the filtration, adsorption, and biological decomposition properties of soils to remove pollutants. Infiltration can provide multiple benefits, including pollutant removal, peak flow control, groundwater recharge, and flood control. Groundwater protection issues must be evaluated when considering infiltration facilities. The DEQ has identified drywells, sumps, and other infiltration-type facilities that inject untreated stormwater below the ground surface as Class V injection wells under the federal underground injection control program.
f. **Significant Resource:** With approval of the Public Works Department authorized representative, certain water quality treatment facilities may be allowed within significant

resource areas. However, natural significant resources are not acceptable as a method for water quality treatment.

3.5.5 Pretreatment Devices – Water Quality Manholes

a. Hydraulic criteria
   1. Minimum design flow = water quality flow.
   2. An upstream flow splitter may be used to bypass conveyance flows in excess of the Water Quality flow.

b. Design criteria
   1. Shall be required immediately upstream of all detention/retention facilities, all water quality treatment facilities, or any release point to a natural drainage.
   2. Minimum manhole diameter shall be 60 inches.
   3. Sump depth shall be no deeper than 5 feet from invert to bottom of sump, unless approved by Public Works Department authorized representative.
   4. Volume of sump shall be 20 cubic feet per 1.0 cfs of flow into the water quality manhole, up to the 25-year flow. Flow calculations shall include the effect of an upstream flow splitter.
   5. Maintain a 3-foot clear access zone between the inside structure wall and the interior outlet structure.
   6. Orient access to structure in a clear zone.

3.5.6 Proprietary Pretreatment Devices

a. Proprietary pretreatment devices are permitted on a case-by-case basis, with approval of the Public Works Department authorized representative.
b. The devices shall be sized in accordance with the manufacturer's recommendations. However, the minimum treatment flow must be the water quality flow.
c. Technical submittals from the manufacturer are required, including hydraulic design criteria, particulate removal efficiency, and maintenance requirements and schedule.

3.5.7 Filtration

a. Biofiltration Swale

Biofiltration swales are vegetated open channels that trap pollutants through filtration. General design requirements for biofiltration swales are given in **Table 3.7.** For more specific design criteria refer to Subsection 10.2.1, "Biofiltration Swale."

Table 3.7. BIOFILTRATION SWALE CRITERIA

Parameter	Requirement
Area to be served	Less than 10 acres
Soils requirements (NRCS classification)	A, B, C, or D (A and B may require liners in certain circumstances)
Maximum ground slopes	10H:1V
Maximum maintained side slopes	4H:1V
Water application rate	Peak flow rate from water quality flow

b. **Sand Filter**

Sand filters are a layer of sand in a sedimentation chamber used to trap pollutants. The water runs into an under-drain system that conveys the filtered stormwater to the discharge point. General design requirements for sand filters are given in **Table 3.8.** For more specific design criteria refer Subsection 10.2.2, "Sand Filter."

Table 3.8. SAND FILTER CRITERIA

Parameter	Requirement
Maximum area to be served	80 acres
Soils requirements (NRCS classification)	A, B, C, or D with limitations
Maximum ground slope	Not applicable
Maximum maintained side slope	4H:1V
Water application rate	2,000 sq. ft. of filter per cfs of design flow

3.5.8 Ponds

Inlet and outlet structures constructed in stormwater ponds shall follow the guidelines provided in Subsection 3.8.4, "Inlets," and Subsection 3.8.5, "Outlets."
Ponds safety shall be in conformance with "Safety" in Subsection 3.3.9, "Detention/Retention Facility Protection."

a. Wet Ponds
Wet ponds are constructed ponds with a permanent pool of water (called pool storage or dead storage). Pollutants are removed from stormwater by gravitational settling, biologic processes, and vegetative filtration. General design requirements for wet ponds are given in **Table 3.9.** For more specific design criteria refer to Subsection 10.3.1, "Wet Ponds."

Table 3.9. WET POND CRITERIA

Parameter	Requirement
Area to be served	2 to 150 acres
Soils requirements (NRCS classification)	C, D (A and B with liners)
Maximum ground slopes	10H:1V
Maximum maintained side slopes	4H:1V

b. Extended Wet Pond
Extended wet ponds are constructed ponds that have both a permanent pool of water and extended detention above the permanent pool. General design requirements for extended wet ponds are given in **Table 3.10.** For more specific design criteria refer to Subsection 10.3.2, "Extended Wet Pond."

Table 3.10. EXTENDED WET POND CRITERIA

Parameter	Requirement

Area to be served	3 to 150 acres
Soils requirements (NRCS classification)	C, D (A and B with liners)
Maximum ground slopes	8 percent
Maximum maintained side slopes	4H:1V

c. Extended Dry Pond
Extended dry ponds are designed to drain completely between storm events. This allows the pond to detain stormwater runoff longer than a standard detention pond and provides some treatment for water quality.
Dry ponds alone seldom meet the design TSS removal requirements established in Subsection 3.5.1, "Water Quality Facility Design Standards," and shall be considered only when combined with other water quality facilities. For more specific design criteria refer to Subsection 10.3.3, "Extended Dry Pond."

3.5.9 Wetlands – Constructed Treatment Wetlands

Constructed treatment wetlands remove pollutants through several processes, including sedimentation, filtration, and biologic uptake. When enough volume is provided, constructed treatment wetlands can also provide a significant level of flow control. General design requirements for constructed treatment wetlands are given in **Table 3.11.** For more specific design criteria refer to Section 10, "Stormwater Quality Facility Design." Inlet and outlet structures constructed in wetland areas shall follow the guidelines provided in Subsection 3.8.4, "Inlets," and Subsection 3.8.5, "Outlets."

Table 3.11. CONSTRUCTED TREATMENT WETLANDS CRITERIA

Parameter	Requirement
Area to be served	No less than 10 acres
Soils requirements (NRCS classification)	C, D (A and B with liners)
Maximum ground slopes	Not applicable
Maximum maintained side slopes	5H:1V

3.5.10 Infiltration

a. A first step in siting and designing infiltration treatment facilities is to conduct a characterization study. Information gathered during initial geotechnical investigations can be used for the site characterization. Key data and issues to be characterized include the following:
   1. Surface features.
   2. Subsurface features.
   3. Infiltration rate determination.
   4. Soil testing.
   5. Infiltration receptor.

b. Site suitability criteria must also be considered for siting infiltration treatment systems, as follows:
   1. Setbacks.
   2. Groundwater protection areas.
   3. High vehicle traffic areas.
   4. Soil infiltration rate/drawdown time.
   5. Depth to bedrock, water table, or impermeable layer.
   6. Soil physical and chemical suitability for treatment.
   7. Seepage analysis and control.
   8. Cold climate and impact of roadway deicers.
   9. Verification testing of the completed facility.

   Note: Refer to Section 9, "Infiltration Requirements, Site Characterization, and Site Suitability Criteria" for a detailed description of site characterization and site suitability criteria. All infiltration systems shall comply with the requirements of the Oregon DEQ UIC (Underground Injection Control) Program.

c. Infiltration Trench
   1. An infiltration trench is a shallow trench in permeable soil that is backfilled with sand and coarse stone and lined with filter fabric. The trench surface may be covered with grating, stone, gabion, sand, or a grassed cover with a surface inlet. General design requirements for infiltration trenches are given in **Table 3.12.** For more specific design criteria refer to Subsection 10.5.1, "Infiltration Trench."

Table 3.12. INFILTRATION TRENCH REQUIREMENTS

Parameter	Requirement
Maximum area to be served	1 acre per trench
Soils requirements (NRCS classification)	A or B only for publicly maintained facilities; C soils may be used for privately owned facilities if drawdown standards are met.
Maximum ground slopes:	5 percent
Soil test requirement	ASTM D 3385

b. Infiltration Basin

   1. An infiltration basin is a depression created by excavation, berms, or small dams to provide for short-term ponding of surface water until it percolates into the soil. General design requirements for infiltration basins are given in **Table 3.13.** For more specific design criteria refer to Subsection 10.5.2, "Infiltration Basin."

Table 3.13. INFILTRATION BASIN REQUIREMENTS

Parameter	Requirement
Maximum area to be served	50 acres

Soils requirements (NRCS classification	A or B only for publicly maintained facilities; C soils may be used for privately owned facilities if drawdown standards are met
Maximum ground slopes	5%
Maximum maintained side slopes	4H:1V
Soil test requirement	ASTM D 3385

3.5.11 Compost Filters

Compost stormwater filters or CSFs, work by percolating stormwater through compost, which traps particulates and adsorbs dissolved materials such as metals and nutrients. Compost filters may be considered as a part of a private water quality treatment facility but will not be allowed as part of a publicly maintained water quality treatment facility.

3.5.12 Other Water Quality Treatment Facilities

The use of other forms of water quality treatment is allowed with the approval of the Public Works Department authorized representative. However, the applicant must provide evidence of the ability of the facility to meet the City's design standards criteria and long-term maintenance requirements. Grass swales will not be allowed.
Information, recommendations, and specific design criteria for facility liners can be found in Section 11, "Stormwater Quality Facility Liners."

3.6 OPERATIONS & MAINTENANCE REQUIREMENT

This section describes operation and maintenance requirements that are generally applicable to all private stormwater facilities. The person designated as the responsible party in the Stormwater Maintenance Covenant and Access Easement shall be responsible for operation and maintenance of private stormwater facilities. An operation and maintenance plan (O&M plan) shall be prepared by the responsible party for the stormwater facility and shall be submitted to the City of Molalla Public Works Department for review and approval. Maintenance activities shall be documented annually by sending a report of what was completed to the City of Molalla Public Works Department, by May 1st of each year.

3.6.1 Inspection Program

a. Routine facility inspection will provide three major benefits:
    1. Development of a condition history.
    2. Improved scheduling efficiency.
    3. Preventive maintenance opportunities.
b. Inspection records shall be used to:
    1. Determine where special maintenance conditions exist.
    2. Determine optimal frequencies for future inspection and maintenance.
    3. Generate scheduled and unscheduled (i.e., repair) work orders.
    4. Assure facility operation and aesthetics.

3.6.2 Inspection Requirements

a. The applicant shall be responsible for having inspections conducted, maintaining stormwater facilities, and submitting yearly reports documenting inspection and maintenance activities to the City of Molalla Public Works Department.

b. Inspect the facility, with the record drawing plans in hand, on a quarterly basis for the first two years, and a minimum of semiannually thereafter. Inspections may be required more frequently, depending on site-specific conditions.
c. All required inspections and any maintenance activities performed shall be documented in the annual report as required by the City's "Stormwater Maintenance Covenant and Access Easement."
d. Inspection reports shall be submitted to the City by May 1st of each year.
e. The applicant shall keep inspection records to track the progressive development of the system over time. The inspection records shall include:
    1. General condition of vegetative area(s), predominant plant species, distribution, and success rate (where applicable).
    2. Sediment condition and depth in forebay (or other pretreatment structure), treatment facility, bench planting zones, and other sediment-removal components.
    3. Water elevations and other observations (sheen, smell, etc.).
    4. Condition of the inlet, outlet, and overflow structures and devices, diversion structures, trash-removal devices, risers, spillway, embankments, and remaining storage capacity.
    5. Unscheduled maintenance needs.
    6. Components that do not meet the performance criteria and require immediate maintenance.
    7. Common problem areas, solutions, and general observations.
    8. Aesthetic conditions.

3.6.3 Structures

Applicant shall be responsible for maintaining all facility structures in good working order. Stormwater facility structures include, but are not limited to, the following: stormwater pipes, stormwater manholes, sand/oil separators, monitoring manholes, flow control devices, energy dissipaters, headwalls, trash grates, underground detention facilities, catch basins, ditch inlets, area drains, clean-outs, access roads, safety fences, sediment fences, and biofiltration bags. Maintenance may consist of cleaning, repairing, and/or replacing structures or portions of structures as needed to maintain their functional purpose.

3.6.4 Planting Bed Soils

a. In areas where greater than 10% of planting bed vegetation has died, have soil tested as recommended by a Professional Landscape Architect registered in the State of Oregon.
b. Amend soil as per recommendations of a Professional Landscape Architect registered in the State of Oregon; if needed redesign plantings to correct problems and reestablish soil coverage.

3.6.5 Vegetation Management

a. Vegetated stormwater facilities may require a number of control practices during their initial 2-year period in order to meet the requirements for establishing healthy vegetation.
b. Requirements
    1. Maintain plantings for a period of two years after the date of final construction approval by the Public Works Department authorized representative. During the establishment period, remove undesired vegetation with minimal (or preferably no) use of toxic herbicides and pesticides at least three times in year 1, and once or twice in the summer of year 2, unless otherwise approved by the Public Works Department authorized representative. Replace plants that die during this period as per recommendations and planting time frame given in Subsection 8.2, "Landscape Guidelines."
    2. At the end of the two-year warranty period, healthy plant establishment shall be achieved for at least 90% of the vegetation (see Subsection 3.13.2, "Landscaping

Inspection for Warranty," for landscape survival criteria). The O&M plan shall specify the long-term maintenance schedule after the warranty period.

3. Selectively irrigate if necessary, during the establishment period, during times of drought, or until the vegetation becomes established. It is preferred that the facility be designed to sustain its function without a permanent irrigation system.
4. Replenish mulch at least annually and specify the mulching schedule in the O&M plan. Mulching shall be done to retain topsoil, heat, and moisture, and to inhibit weed growth. Use temporary fencing to protect seedlings from foraging animals.
5. Schedule maintenance outside sensitive wildlife and vegetation seasons. Minimize plant disturbance during maintenance activities.
6. Do not use fertilizers, herbicides, or pesticides for vegetation maintenance, unless it is specifically called for in the O&M plan.

c. Use replacement plants that conform to the initial planting plan and to Section 8, "Landscape Requirements for Stormwater Facilities."

3.6.6 Sediment Management/Pollution Control

a. Sediment and other pollutants that degrade water quality will accumulate in stormwater facilities. The contractor shall remove all accumulated pollutants and sediment to maintain proper facility operation. Periodic testing will help determine appropriate sediment-removal schedules.
b. Requirements:
    1. Place a sediment marker in the forebay or in an area not likely to be damaged by incoming storm flows and where it can be easily seen by maintenance personnel.
    2. Remove sediment when accumulations reach 1 foot in depth, 50% of the designed sediment storage depth, or if sediment accumulation inhibits facility operation. The 50% full capacity shall be identified and marked on sediment marker during facility construction.
    3. Test sediment before removing it if the stormwater facility serves a commercial/industrial site or a multifamily structure or development. Sediment shall be tested according to protocol established in the O&M plan, and any additional information resulting from site-specific conditions and use. Testing could include parameters such as oil and grease, heavy metals (lead, zinc, and cadmium), nutrients (e.g., phosphorus), and organics such as pesticides that may accumulate. Testing must be site specific if a commercial/industrial discharger is being served; City of Molalla reserves the right to require testing of specific contaminants. Applicant shall provide the test results to the City of Molalla Public Works Department prior to excavation and disposal of sediment.
    4. Dispose of sediments at the time of excavation in a manner meeting applicable state and federal requirements. If sediment disposal requires special handling, disposal documentation shall be provided to the City of Molalla Public Works Department.
    5. Investigate and control, or report the pollutant source, if sediment or other pollutants are accumulating more rapidly than assumed when the O&M plan was formulated. Direct pollution-control complaints to the City of Molalla Public Works Department.

3.6.7 Insect/Vector Control

a. Standing water associated with some types of treatment systems can attract insects.
b. The following measures shall be the primary methods of insect control. The methods are not presented in order of implementation, but one or all of these methods shall be used before considering any other measures:
    1. Install predacious bird and bat nesting boxes.

2. Change the water level of ponds every four days or so to disrupt the larval development cycle of mosquitoes.
3. Stock ponds and other permanent water facilities with fish or other predatory species.
4. Use mosquito larvicide, such as Bacillus thurengensis or Altoside® formulations, only if absolutely necessary. Any pesticide or larvicide shall be applied by a licensed individual.

c. Additional assistance with vector monitoring and control may be obtained from the local vector control office.

3.6.8 Access and Safety

O&M programs shall provide for safe and efficient access to a facility and shall be in compliance with Subsection 1.17.9, "Safety Requirements". The following are general requirements; specific conditions may require site-specific modifications:

a. Secure easements necessary to provide facility and maintenance access (if applicable).
b. Use only trained and certified personnel to access confined spaces.
c. Maintain ingress/egress routes to design standards, in a manner that allows efficient maintenance of the facility.
d. Ensure that fencing is in good repair.

3.7 CONSTRUCTED CHANNEL DESIGN STANDARDS

3.7.1 Application

This section applies to open channels constructed to convey runoff to the existing public stormwater and surface water conveyance system. For work in existing stream channels, applicant shall follow the recommendation and requirements set forth in ODFW's *Fish Passage Criteria,* or latest edition, or an equivalent study or guideline approved by the Public Works Department authorized representative. The applicant shall comply with all applicable requirements of the Army Corps of Engineers and Oregon Department of State Lands for construction activities that may impact wetlands or waterways. Development that regrades existing roadside ditches or constructs new roadside ditches shall meet applicable City codes and standards.

3.7.2 Channel Design

a. Channel design shall be in accordance with Subsection 3.3, "Hydrology and Hydraulics."
b. Vegetation-lined channels shall be used whenever practicable, as determined by the Public Works Department authorized representative. Rock-lined channels shall be used only where a vegetative lining will not provide adequate protection from erosion. Channels shall be protected in conformance with Subsection 3.3.7, "Channel protection."
c. Constructed open channels shall be sized to pass the required flows and have side slopes no steeper than 2H:1V. Any proposed constructed channel improvement that does not meet these requirements shall be piped, unless an exception is approved by the Public Works Department authorized representative.
d. Normal maximum depth for open channels constructed adjacent to roadways shall be 2 feet.
e. No protruding pipes, culverts, utilities, or other structures will be allowed that reduce or hinder the flow characteristics of the channel. Channels and connections shall be designed to prevent scouring. All pipe connections shall match side slopes, incorporate a headwall, and be designed with an energy dissipater device (see Subsection 3.3.7, "Channel Protection," and Subsection 3.3.8, "Outfall Protection").

3.7.3 Channel Construction for New Roadside Ditches

Roadside ditches shall be constructed in conformance with ODOT SSC Section 00330, "Earthwork."

3.8 CULVERT DESIGN STANDARDS

3.8.1 Application

a. Culverts provide for passage of water under or through obstructions placed across streams and drainage ways. Culverts shall be designed to pass the required flows without compromising public safety or causing new or additional flooding.
b. For pipe systems or culverts that convey flows from a stream or through sensitive areas, a local representative of ODFW or other applicable state or federal agency shall be contacted to determine whether fish passage is required and to identify site-specific design criteria. Additionally, ODFW may require fish passage accommodations on any stream that has a history or the potential for fish production.
c. All culverts shall be designed for fish passage in accordance with ODFW's *Fish Passage Criteria,* or latest edition, unless otherwise exempted by ODFW and the City.

3.8.2 Hydraulic Design

Culverts shall be designed to safely pass the 25-year flow.

3.8.3 Headwater

a. For new culverts 18 inches in diameter or less, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed two times the pipe diameter or three times the pipe diameter with a seepage collar, unless an exception is approved by the Public Works Department authorized representative.
b. For new culverts larger than 18 inches in diameter, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter, unless an exception is approved by the Public Works Department authorized representative.
c. The maximum headwater elevation of a design storm event for new culverts shall be at least 1 foot lower than the road or parking lot subgrade

3.8.4 Inlets

The embankment around the culvert inlet shall be protected from erosion by lining around the inlet with rock, bioengineering, or other protection approved by the Public Works Department authorized representative. The lining shall extend upstream of the culvert a minimum of 10 feet, be designed to provide a smooth transition for water flow into the culvert and shall be as high as the designed headwater elevation. Trash racks or debris barriers shall follow the design requirements of Subsection 3.9.6, "Trash Racks or Debris Barriers."

3.8.5 Outlets

The receiving channel of the outlet shall be protected from erosion by rock lining, bioengineering, or other energy dissipating devices (Subsection 3.3.7, "Channel Protection," and Subsection 3.3.8, "Outfall Protection") as approved by the Public Works Department authorized representative.

3.8.6 Inlet Control Analysis

The headwater depth for pipes under inlet control shall be determined using the nomographs as provided in details of these standards, the ODOT "Hydraulics Manual," or a modeling method consistent with FHWA's HY8 software.

3.8.7 Outlet Control Analysis

The headwater depth for pipes under outlet control shall be determined using the nomographs as provided in details of these standards, the ODOT "Hydraulics Manual", or a modeling method consistent with FHWA's HY8 software.

3.8.8 Outfall Design Standards

a. Outfalls shall be above the mean low-water level, unless an exception is approved by the Public Works Department authorized representative. All outfalls shall be provided with a rock splash pad or other approved erosion-control measure. Erosion protection at outfalls shall be designed in accordance with the guidelines in Subsection 3.3.8, "Outfall Protection," unless exceptions are approved by the Public Works Department authorized representative.
b. Mechanisms that reduce velocity before water discharges from an outfall are required. The dissipaters shall be designed using published references such as FHWA's "Hydraulic Design of Energy Dissipaters for Culverts and Channels," the ODOT "Hydraulics Manual", and others. Design references shall be cited in the construction plan submittal.
c. Non-erosive stormwater flow velocities shall be maintained for the entire overland flow from the energy dissipating device to the receiving public waterway. The Public Works Department authorized representative shall approve structures and/or methods to maintain non-erosive flow velocities prior to construction or installation.

3.9 STORM MANHOLE & PIPE DESIGN STANDARDS

3.9.1 Manhole Design

a. Manholes shall be provided at least every 400 feet, unless otherwise approved by the Public Works Department authorized representative. Manholes shall be located at every grade change, change in pipe size, and change in alignment. Unless an exception is approved by the City, manhole lids placed within the paved right-of-way shall have a minimum of 5 feet of clearance from the edge of a curb or gutter and shall not be in a wheel path of the traveled way (see Street detail drawings of these standards).
b. When a manhole is 5 feet or less deep, a flat-top or shallow manhole shall be used. Flat-top manholes shall be designed to be installed at an elevation to permit construction of the full street section, allowing for the design gradients.
c. All manholes shall be a minimum of 48 inches in diameter for pipe sized up to 18-inches diameter, minimum 60-inch diameter manhole for 18-inch to 30-inch pipe diameter, and minimum 72-inch manhole for 30-inch and larger pipe diameter.
d. Suburban style manholes frames shall not be used in PCC streets.
e. There shall be a maximum of 4 pipes entering/exiting a manhole unless otherwise approved by Public Works Department authorized representative.
f. Detail(s) shall be submitted with the plans where pipes into or out of a manhole are larger than 24 inches or where more than four mainline connections are made. The manufacturer or design engineer shall provide the Public Works Department authorized representative with supporting calculations, stamped by a Professional Engineer registered in the State of Oregon, documenting the structural integrity of the manhole.
g. Connections to an existing manhole, elevation of the existing ledge, location of steps, and elevations of existing inlets and outlets shall be submitted with the plans.
h. All precast manhole bases shall have smooth, clean openings at the design inlets and outlet points. Openings shall not be saw cut or broken out.
i. All manhole bases shall be properly channelized. No more than three side laterals are allowed to be connected to a manhole, unless an exception is approved by the Public Works

Department authorized representative. There shall be a minimum of 8 inches separating connections, measured from the outside diameter of the core holes.

j. All manholes shall have inlets at a minimum 90-degree angle in relation to the outlet, as measured from the center of the manhole base.
k. Manholes shall have a minimum freefall of 0.10 feet and a maximum freefall of 1.5 feet.
l. Drop manholes: The maximum inside drop in a manhole shall be 18 inches. When more than 18 inches of drop exists, an outside drop manhole shall be used. Outside drops shall be constructed of ductile iron pipe.
m. An oversize curb inlet manhole may be used in lieu of a manhole, as required by this subsection, when approved as part of a flow-through system. Oversized gutter or curb and gutter catch basins will be allowed in lieu of manholes, with approval of the Public Works Department authorized representative.
n. Water Quality Manhole Design: Refer to Subsection 3.5.5, "Pretreatment Devices - Water Quality Manholes."

3.9.2 Storm Pipe Design

a. **Pipe size:** The design size shall be based on hydraulic calculations provided by the design engineer. The minimum diameter of public storm pipe is identified below:
    1. Pipe from the catch basin to the mainline in the public right-of-way shall be nominal 10-inch-diameter pipe.
    2. Mainline pipe shall be nominal 12-inch-diameter pipe.
    3. Storm pipes located out of a public street right-of-way, with no reasonable need to be extended, and with roof drains or area drains connected, shall be a minimum 10-inch-diameter pipe.
b. **Location:** Storm sewers, wherever possible, shall be installed behind and parallel to the face of curb on either side of the street as indicated in the street detail drawings of these standards. All storm sewer locations shall be approved by the Public Works Department authorized representative. Storm drain inlets shall be designed as per Subsection 3.2.7, "Catch Basin System Standards" and Subsection 3.9.7, "Drain Inlet Design Standards."
c. **Easements:** When it is not possible or practical to install the sewer line in a dedicated public street, a minimum 15-foot public pipeline easement shall be provided. Sewer lines shall be located in the center of the easement, unless an exception is approved by the Public Works Department authorized representative. The centerline of the pipe shall be at least 7½ feet from an easement side line.
d. **Alignment:** Public storm pipe shall be laid on a straight alignment and at uniform grade, unless an exception is approved by the Public Works Department authorized representative.
e. **Connections:** Lateral connections on new construction work shall be done using manufactured tees installed at surveyed locations. Lateral connections to existing storm lines may be done using either saddle tees or by using Inserta Tee® as per Subsection 3.10.3, "Stormwater Pipe and Fittings". Laterals shall be of same material as main.
f. **Laterals:** Storm laterals shall be provided with a cleanout installed at the public right-of-way or easement. Cleanouts shall not be installed in the driveway or sidewalk, unless approved by the Public Works Department authorized representative.
g. **Curb Marking:** Newly constructed curbs or replaced curbs shall be stamped with the capital letters "D" at the location of each storm lateral crossing. Letters shall be 3 inches in height and embossed a minimum of ⅛-inch deep.
h. **Locating Wire and Tape:** Storm laterals and mains shall have tracer wire (14-gauge with white insulation) installed beside the pipe. Surface locating wire at right-of-way cleanouts or shall be tied off to the 2 x 4 marker until cleanout is installed.

i. **Grade:** All storm lines shall have sufficient slope to maintain a minimum flow velocity of 3 feet per second when flowing full.

j. **Steep Slopes:** Where soil conditions warrant it, storm pipes on slopes in excess of 20% gradient shall be secured with approved anchor walls. Spacing for anchors shall be as shown in **Table 3.14**.

Table 3.14. SECURING SEWERS ON SLOPES

Minimum Anchor Spacing Sewer Gradient >20%	
Grade (%)	**Center to Center (feet)**
<35	35
35-50	25
>50	15 (or concrete encasement)

k. **Pipe Cover:** Minimum pipe cover shall be in compliance with this section, unless an exception is approved by the Public Works Department authorized representative. In paved areas, pipe cover shall be measured from the finished grade to the upper surface of the pipe barrel; the pipe bell shall not intrude into the base rock. In areas without pavement, the pipe cover shall be measured from the finish grade to the upper surface of the pipe barrel. Minimum cover requirements are shown in **Table 3.15.**

Table 3.15. MINIMUM PIPE COVER

Type of Pipe	Cover (inches)
Other Pipe Materials	30
Nonreinforced	30
RCP Class III	30
RCP Class IV	24
RCP Class V	12
AWWA C-900, C-905	12
ADS SaniTite HP	12
Ductile Iron	12

3.9.3 Distance between Structures

The maximum distance between structures, such as manholes, area drains, and catch basins, but excluding cleanouts, for 12-inch and larger pipe shall be 400 feet.

3.9.4 Access

Access roads are for maintenance and inspection purposes. All-weather access shall be provided to every manhole. Access roads shall be constructed as per Subsection 3.4.4, “Access Road Design.”

3.9.5 Headwalls

Pipe end protection shall be required where pipe material other than concrete or ductile iron is exposed in the design of an outlet or inlet pipe or where required to stabilize a slope. Details of all headwalls and end protection shall be included in the construction drawings.

3.9.6 Trash Racks or Debris Barriers

Trash racks or debris barriers are required by the City on inlets for pipe or culvert systems greater than 18 inches in diameter. The design engineer shall submit the trash rack/debris barrier system design to the Public Works Department authorized representative for approval.

3.9.7 Drain Inlet Design Standards

All inlets and catch basins shall be designed to accept a 10-year storm event. Grates shall be designed, as far as practical, to avoid failure due to accumulation of debris.

a. Design Criteria

a. Precast and poured-in-place-catch basins and curb inlets are allowed.
b. All catch basins shall be constructed with an 18-inch minimum sump unless they are part of a series or a flow-through catch basin system and approved by the Public Works Department authorized representative.
c. A main storm line shall not pass through a sumped catch basin.
d. Avoid placing curb inlets along curb radius at street intersections.
e. Spacing of catch basins shall be determined by the capacity of each to pass a 10-year storm event. In addition, catch basins shall be installed just before the upstream curb radius at all intersections.
f. Catch basins, except for CG-48 (curb inlet), shall be a maximum depth of 6 feet from the top of grate to the flow line of the lowest pipe invert. When depth from top of grate to flow line is greater than 5 feet, catch basins shall be oversized and have steps installed.
g. Between the inlet and the mainline or mainline structure, the maximum length of pipeline shall be 40 feet for 10-inch pipe and 60 feet for 12-inch pipe, unless additional length is required to cross the street right-of-way.
h. Tee connections may be used in street right-of-way only with approval of the Public Works Department authorized representative. The lateral shall be no larger than 50% the diameter of the main line, unless otherwise approved by the Public Works Department authorized representative. The connecting catch basin shall be oversized for cleaning purposes.

i. **Area Drains and Ditch Inlets**

1. The standard area drain shall be as shown in details of these standards, and the ditch inlet shall be as shown in details of these standards, unless an exception is approved by the Public Works Department authorized representative.
2. Area drains in rear or side yards shall not be sumped. Ditch inlets shall be equipped with an 18-inch sump unless the inlets are part of a flow-through system.
3. A main storm line shall not pass through an area drain or a ditch inlet.
4. Area drains or ditch inlets may be located at the upper terminus of a main storm line, may connect to the main storm line at a manhole, or may connect to the main storm line through a tee when the lateral is no larger than 50% of the diameter of the main line.

3.10 MATERIAL SPECIFICATIONS

3.10.1 Manholes and Structures

a. General

Manholes shall be constructed at locations shown on the plans or as required by the Public Works Department authorized representative. The maximum distance between manholes shall be 400 feet, unless otherwise approved by the Public Works Department authorized representative. All manholes shall be a minimum of 48 inches in diameter. When a manhole is less than 5 feet deep, a shallow or flat-top manhole shall be used. Flat-top manholes shall be installed at an elevation to allow for construction of the full street section, allowing for the design gradients.

b. Materials
   1. **Aggregate and Cement:** Aggregate shall meet the standards set forth in ODOT SSC Section 02690, "PCC Aggregates"; Portland cement shall meet the standards set forth in ODOT SSC Section 020, "Portland Cement."
   2. **Concrete:** PCC for poured in place manholes and structures shall conform to ODOT Class 3000 – 1½, Commercial Grade Concrete. Slump shall be between 2 and 4 inches.
   3. **Manhole Frames and Covers:**
      (a) Casting shall be of new material, tough, close-grained gray iron conforming to ASTM A-48, Class 30, and shall be smooth and clean, free of blisters, blowholes, and all defects. Bearing surfaces shall be planed or ground to ensure flat, true surfaces. Covers shall be true and set within rings at all points.
      (b) Rings shall be grouted in place and made watertight with a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout® or approved equal. Unused grout shall be discarded after 20 minutes and shall not be used. Rings shall not be brought to grade with lumber.
      (c) Frames and covers shall be standard or suburban, depending on the manhole location and as approved by the Public Works Department authorized representative. Suburban style manhole frames shall not be installed in PCC streets.
      (d) Manholes installed outside of paved street or sidewalk areas shall be installed with a tamperproof frame and cover.
   4. **Manhole Types:** Manholes shall be one of the following types or equal.
      (a) **Precast 48-Inch-Diameter Manholes:** Materials shall conform to the requirements of ASTM C-478. Minimum wall thickness shall be 5 inches. Cones shall be eccentric. Before precast manhole sections of any size are delivered to the job site, the sections shall meet the permeability test requirements of ASTM C-14.
      (b) **Precast Large-Diameter (60-inch or larger) Manholes:** Materials shall conform to the requirements of ASTM C-478.
      (c) **Cast-in-Place Large-Diameter Manholes:** Aggregate shall meet the standards set forth in ODOT SSC Section 02690, "PCC Aggregates"; Portland cement shall meet the standards set forth in ODOT SSC Section 020, "Portland Cement."
      (d) **Precast Bases:** Precast base sections or manhole bases shall be used, except over existing pipe where poured-in-place bases shall be used. Precast manhole bases shall be inspected and approved by the Public Works Department authorized representative prior to installation. Where precast bases are not channelized, the contractor shall construct smooth channels to connect the flow from inlet pipe(s) to outlet pipe.
      (e) **Poured-in-Place Bases:** Poured-in-place bases shall be used over existing pipelines. The contractor shall remove water from the excavated area, provide a minimum 8-inch-thick layer of compacted 1"-0" crushed aggregate for a base, and construct the concrete base so that the first precast manhole section has a uniform bearing throughout the full circumference. There shall be a minimum of 8 inches of concrete between the compacted gravel and the lowest invert of the manhole. The

contractor shall deposit sufficient concrete on the base to assure a watertight seal between base and manhole wall. Twenty-four hours shall be allowed to elapse before the remaining manhole sections are placed on the base, unless otherwise approved by the Public Works Department authorized representative.

5. **Pipe Stub-outs for Future Sewer Connections:** Pipe stub-outs shall be the same type as approved for use in the lateral, main, or trunk sewer construction. Strength classifications shall be the same class as in adjacent trenches. Where two different classes of pipe exist at a manhole, the higher-strength pipe shall govern strength classification. Connect stub-outs to manholes as specified in this subsection, "Connection to Existing Manholes." Rubber-gasketed, watertight plugs shall be furnished with each stub-out and shall be adequately braced against air test pressures.
6. **Gaskets:** Manhole sections shall be installed with either preformed rubber gaskets or plastic gaskets. Rubber gaskets shall conform to ASTM C-443. Plastic gaskets shall be Kent-seal No. 2 or Ram Neck, or approved equal, and shall meet all requirements of ASTM C-990.
7. **Manhole Steps**: Steps shall be required and shall be constructed unless otherwise approved by the Public Works Department authorized representative. When pipe is 24 inches in diameter or smaller, steps shall be located as indicated in standard details. For pipe larger than 24 inches in diameter, steps shall be located over a bench as coordinated with the Public Works Department authorized representative. Maximum drop from rim to first step shall be 27 inches.

c. Workmanship
   a. **Foundation Stabilization:** If, in the opinion of the geotechnical engineer or the Public Works Department authorized representative, unstable subgrade material exists that will not support the manhole or other structure, the contractor shall excavate below grade and backfill with foundation-stabilization material approved by the Public Works Department authorized representative.
   b. **Pipe Connections:** All rigid pipes entering or leaving the manhole shall be provided with flexible joints within 1 foot of the manhole structure and shall be placed on firmly compacted bedding. Special care shall be taken to see that the openings through which pipes enter the structure are completely watertight. All flexible pipe shall be connected to manholes according to the manufacturer's recommendations.
   c. **Flexible Joints:** Where the last joint of the line laid up to the manhole is more than 1 foot from the manhole base, a 6-inch concrete encasement shall be constructed around the entire pipe, from the manhole base to within 1 foot of the pipe joint, at the discretion of the Public Works Department authorized representative. The pipe encasement shall be constructed integrally with the manhole base. Pipes laid out of the manhole shall be shortened to ensure that the first flexible joint is no more than 1 foot from the manhole base.
   d. **Manhole Connections:** The contractor shall connect sewer pipe to manholes as specified in this Subsection, "Types of Connections."
   e. **Drop Manholes**
      (a) The maximum inside drop in a manhole shall be 18 inches. See also in this Subsection, "Shallow Inside Drop Manhole," for construction of this connection.
      (b) When more than 18 inches feet of drop exists, an outside drop manhole shall be used. Outside drop manholes shall use ductile iron pipe with mechanical joints.
   f. **Placing Manhole Section:** The contractor shall clean the end of each sections of foreign material. Manholes shall be installed with either watertight rubber O-rings or preformed plastic gaskets in conformance with the manufacturers' recommendations. If plastic gaskets are used, the inside seams shall be grouted with a high-strength, non-shrink

grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout® or approved equal. Unused grout shall be discarded after 20 minutes and shall not be used. Manholes will be visually inspected for water leakage by the Public Works Department authorized representative. Any leakage observed shall be repaired at the contractor's expense, and the manhole re-inspected.

g. **Manhole Inverts:** The contractor shall construct manhole inverts in conformance with these standards. Inverts shall have smooth transitions to ensure an unobstructed flow through the manhole. The contractor shall remove all sharp edges or rough sections that tend to obstruct flow.
h. **Manhole Stub-outs:** The contractor shall install stub-outs from manholes for future extensions, as shown in these standards or as required by the Public Works Department authorized representative. A watertight flexible connection shall be used for pipe sizes 6 inches through 18 inches in all new manholes. The contractor shall construct invert channels in accordance with standard details. The minimum length of stub-outs in existing manholes shall be 12 inches from the outside manhole wall. Pipes shall be grouted in precast walls or the manhole base to create a watertight seal around the pipes. The contractor shall add compacted base rock, as specified in these standards, to undisturbed earth under all stub-outs.
i. **Manhole Extensions, Rings, and Covers:** The contractor shall install rings and covers on top of manholes to prevent all infiltration of surface water or groundwater into manholes. Rings shall be set in a bed of high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal, with the grout carried over the flange of the ring, and shall be set so that tops of covers are flush with the surface of the adjoining pavement, or 1 foot above natural ground, unless otherwise directed by the Public Works Department authorized representative. Unused grout shall be discarded after 20 minutes and shall not be used. Total thickness of grade rings shall not exceed 12 inches; rings shall be grouted watertight. Drop from rim to first manhole step shall not exceed 27 inches. In designated floodplain areas, all manholes shall be at an elevation of at least 2 feet greater than the 100-year storm event.

d. Types of Connections
   1. **Connection to Existing Manholes:** The contractor shall connect sewers to existing manholes at the locations shown on the plans. Contractor shall submit a plan for diversion control and receive written approval from the Public Works Department authorized representative before proceeding with construction. The contractor shall provide all diversion facilities and shall perform all work necessary to maintain sewage flow in existing sewers while connections are being made to the manholes. Connections to existing manholes shall be core-drilled, and the bases shall be grouted as necessary to allow a smooth flow into and through the existing manholes.
   2. **Manholes over Existing Sewers:** The contractor shall construct manholes over existing operating sewer lines at the locations shown on the plans. The contractor shall construct a poured-in place base under the existing sewer and the precast sections as specified. The contractor shall not cut into any existing lines until the new manhole(s) are grouted and the new lines are balled, flushed, and deflection tested, and all portions of the storm line have been approved and accepted by the Public Works Department authorized representative. After acceptance, the contractor shall saw cut into the existing line; cut edges of concrete pipe shall be covered with grout and troweled smooth; with ductile iron or plastic pipe, grout shall be applied up to cutout and troweled smooth.

3. **Shallow Inside Drop Manhole:** Where the invert of the connecting pipe is above the manhole shelf and less than 18 inches above the outlet, an inside drop shall be constructed utilizing Portland cement concrete. The stormwater entering the manhole shall follow a smooth concrete channel transitioning evenly from the invert of the inlet pipe into the main channel. Stormwater shall not be allowed to fall freely to the manhole base.

3.10.2 Catch Basins and Inlets

a. Materials

1. Aggregate, Cement, and Concrete: These materials shall meet the requirements of Subsection 3.10.2, "Manholes and Structures."
2. Frames, Grates, and Covers: All materials shall be flat bar steel (standard grade), cast iron or ductile iron complying with the requirements of ASTM A-36, A-663, or A-709. Drainage grate inlets in paved roadways shall meet the requirements of "Drainage Grates" in Subsection 7.2.2, "On-Street Design Standards."
3. Forms: All exterior surfaces shall be formed with steel or plywood. Other surfaces shall be formed with matched boards, plywood, or other approved material. Trench walls, rock, or earth will not be acceptable as form material.
4. Metal Reinforcement: All metal reinforcement shall conform to the requirements of ASTM A-615, Grade 60, deformed bars.
5. Precast Concrete Units: All precast units shall conform to the same requirements as manholes (ASTM C-478).

b. Workmanship

1. Excavation and backfill shall conform to the requirements of "Workmanship" In Subsection 3.10.1, "Manholes and Structures."
2. Bedding: The contractor shall remove all water and debris from the excavation area and shall install an 8-inch-minimum layer of compacted 1"-0" crushed aggregate for a base.
3. Cast-in-Place: Cast-in-place catch basins shall have a minimum of 6 inches of concrete between the compacted crushed aggregate and the lowest invert. The forms used for cast-in-place catch basins shall be tight and well-braced. The storm pipe material shall extend into the poured concrete of the catch basin. All corners shall be chamfered. Immediately after placement, the concrete shall be consolidated with an approved vibrator. The top surface shall be screed, and exposed surfaces shall be troweled to a smooth finish, free from marks or irregularities. After forms are removed, the contractor shall patch any defects in the concrete with approved material.
4. Precast: After the base is prepared, the contractor shall set the precast catch basin to the proper line and grade. The storm pipe material being used shall connect to the precast catch basin.
5. Inverts, Stub-outs, and Sections: Contractor shall clean the ends of all pipes and sections that contact the catch basin. All inverts, stub-outs, and sections shall be installed according to these standards, using a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal, making sure all sharp edges or rough sections are removed, to prevent obstruction of the flow. Unused grout shall be discarded after 20 minutes and shall not be used.
6. Catch Basin Steps: All catch basins deeper than 5 feet, measured from the top of the frame to the flow line, shall be oversized and have steps.

3.10.3 Stormwater Pipe and Fittings

a. General

The materials used shall be adequate to carry anticipated dead and live loads within the deflection limits specified by the manufacturer. All pipe and culverts shall have a minimum design service life of 75 years. Joints shall be gasketed, unless otherwise approved by the Public Works Department authorized representative.

b. Materials

Materials shall be the following types or approved equal:

1. Concrete Pipe (NRCP/RCP):
   (a) Non-reinforced concrete pipe shall conform to requirements of ASTM C-14. Unless otherwise specified, pipe shall conform to Class 3 design requirements.
   (b) Reinforced concrete, non-pressure pipe shall conform to the requirements of ASTM C-76 or C-655 and shall be of the class specified. Unless otherwise specified, pipe shall meet the design requirements of Wall B. Reinforced concrete low-head pressure pipe shall conform to the requirements of ASTM C-361.
   (c) Gaskets shall conform to the requirements of ASTM C-443.
   (d) All steam-cured concrete pipe must be at least seven days old before it can be used. If the pipe has not been steam-cured, it must not be used before it has cured for 28 days.
   (e) Fittings shall be manufactured integrally and be of a class at least equal to that of the adjacent pipe. Field taps shall be machine-drilled.
   (f) Mortar used shall be standard non-shrink premixed mortar conforming to ASTM C-387 or in a proportion of one-part Type II Portland cement to two parts clean, well-graded sand that will pass a ⅛-inch screen. Mortar mixed for longer than 30 minutes shall not be used.
2. Ductile Iron Pipe (D.I.):
   (a) Ductile iron pipe shall conform to the requirements of American Water Works Association (AWWA) C-151 or American National Standards Institute (ANSI) A21.51, cement lined push-on joint. The minimum thickness class shall be Class 50 (up through 12-inch diameter pipe) and Class 51 (for 14-inch diameter and larger pipe).
   (b) Fittings shall be mechanical or push-on. Mechanical joint ductile iron fittings shall conform to AWWA C-110. Push-on joint fittings shall be gray iron, with body thickness and radii of curvature conforming to ANSI A-21.10. Rubber gasket joints shall conform to AWWA C-111/ANSI A-21.11.
3. Polyvinyl Chloride Pipe (PVC):
   (a) PVC pipe shall conform to the applicable portions of the following specifications: ASTM D-3034, ASTM D-2729, ASTM D-1784, ASTM D-1785, ASTM F-679, ASTM F-794, AWWA C-900, and AWWA C-905.
   (b) PVC fittings shall conform to the applicable portions of the following specifications: ASTM D-3034, ASTM D-2729, ASTM D-1785, ASTM D-2466, and ASTM D-2467. Fitting joints shall be the same as the pipe joints. Threaded connections shall conform to the requirements of ASTM D-2464 for schedule 80 pipe.
   (c) A2000 (PVC): All A2000 PVC pipe and fittings shall conform to ASTM F-949 specifications.
   (d) PVC rib: PVC rib pipe and fittings shall be made of PVC, as defined ire ASTM D-1784. The pipe stiffness shall correspond with the series, in accordance with ASTM D-2412. Series 46 and 28 are allowed. Gaskets shall conform to ASTM F-477.
4. Corrugated polyethylene (CPP):
   (a) Corrugated polyethylene pipe, double wall, and fittings shall be made of polyethylene compounds that conform with the physical requirements of Type III, Category 3, 4 or 5, P23, P33, P34, Class C, with the applicable requirements

defined in ASTM D-1248. Spiral pipe is not acceptable. Corrugated polyethylene pipe shall conform to AASHTO M-294 specifications.

5. Corrugated Aluminum (CAP) and Corrugated Aluminum Pipe Arches (CAPA):
   (a) Corrugated aluminum pipe and fittings shall conform to the requirements of AASHTO M-196 and AASHTO M-197.
   (b) The connecting bands shall conform to the requirements of AASHTO M-196, except that the minimum width of bands for 12-inch and larger pipe shall be 12 inches. The minimum width for pipes less than 12 inches shall be 7 inches. The base metal of the connecting bands shall be the same base metal as that of the pipe. The gauge of the connecting bands may be two standard-use thicknesses lighter than that used for the pipe, but not less than 0.060 inch thick. The band couplers shall be connected with stainless steel bolts not less than 0.5 inch in diameter.
   (c) Corrugated aluminum pipe shall not be placed in a ditch in direct contact with hydrating Portland cement or lime.
6. Fittings:
   (a) General
      (1) Manufactured tee fittings shall be provided in the sewer main for side sewers. Fittings shall be of sufficient strength to withstand all handling and load stresses encountered.
      (2) Fittings shall be of the same materials as the pipe. Material joining the fittings shall be of the same material as the pipe.
      (3) Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface.
      (4) All fittings shall be capped or plugged and shall be gasketed with the same gasket material as the pipe joint, fitted with an approved mechanical stopper, or have an integrally cast knockout lug. The plug shall be able to withstand all test pressures without leaking. When later removed, the plug shall permit continuation of piping with jointing similar to joints in the installed line.
   (b) Mechanical Couplings: Mechanical couplings shall be wrought steel. Installation procedures must meet the manufacturers' recommendations.
7. Line Tap Saddle:
   All saddles approved for sanitary sewer tap installation (see Subsection 4.4.2, "Gravity Sewer Pipe and Fittings) shall be allowed on storm taps, except the following:
   (a) DFW/HPI saddle—an elastomeric polyvinyl chloride saddle with steel-reinforced edges and stainless-steel bands, series 300. This saddle is allowed on PVC, clay, IPS, concrete, asbestos cement, and PE pipe.
   (b) Saddles installed on corrugated aluminum pipe shall be fabricated and installed using stainless-steel nuts and bolts. Bolts and nuts shall conform to AWWA C-111/ANSI A21.11.

c. Workmanship
   1. Line and Grade:
      (a) Survey control hubs for both line and grade shall be provided by the design engineer in a manner consistent with accepted practice. The contractor shall establish line and grade for pipe by the use of lasers or by transferring the cut from the offset stakes to the trench at a maximum of 50-foot intervals to maintain the line and grade.
      (b) Variance from the established line and grade shall not be greater than ¼ inch for grade and ½ inch for line, provided that such variation does not result in a level or reverse-sloping invert.

(c) The contractor shall check line and grade as necessary. If the limits prescribed in these standards are not met, the work shall be immediately stopped, the Public Works Department authorized representative notified, and the cause remedied before proceeding with the work.
(d) Variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, shall not exceed 1/64 per inch of pipe diameter, or ½ inch maximum.
(e) Tee stations shall be staked as specified in Subsection 3.1.7, "Surveying," to enable the contractor to install services at the correct property location.

2. Pipe Handling:
   (a) The contractor shall unload pipe only by approved means. Pipe shall not be unloaded by dropping it to the ground and pipe shall not be dropped or dumped into trenches.
   (b) The contractor shall inspect all pipe and fittings before lowering them into trenches to ensure that no cracked, broken, or otherwise defective materials are used.
   (c) The contractor shall clean the ends of pipe thoroughly, remove foreign matter and dirt from inside the pipe, and keep it clean during laying and joining.
   (d) The contractor shall lower the pipe into the trench in such a manner as to avoid any physical damage to the pipe.
   (e) The contractor shall remove all damaged pipe from the job site.
3. Foreign Material:
   (a) The contractor shall take all necessary precautions to prevent excavated or other foreign material from entering the pipe during the laying operation.
   (b) At all times, when laying operations are not in progress, the contractor shall use a mechanical plug at the open end of the last laid section of pipe to prevent entry of foreign material or creep of the gasketed joints.
4. Pipe Laying:
   (a) Pipe laying shall proceed upgrade, with the spigot ends pointing in the direction of flow.
   (b) After a section of pipe is lowered into the prepared trench, the contractor shall clean the end of the pipe to be joined, the inside of the joint, and the rubber ring (if required) immediately before joining the pipe.
   (c) At the location of each joint, dig bell (joint) holes of ample dimensions in the bottom of the trench and at the sides, where necessary, to permit the joint to be made properly.
   (d) The joint shall be assembled according to the recommendations of the manufacturer. The contractor shall provide all special tools and appliances required for the joint assembly. After the joint is made, the pipe shall be checked for alignment and grade.
   (e) The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between joints.
   (f) Do not lay pipe in water or when, in the opinion of the Public Works Department authorized representative, trench conditions are unsuitable.
5. Movable Shield: When pipe is laid in a movable trench shield, the contractor shall take all necessary precautions to prevent the pipe joints from pulling apart when the shield is moved ahead. The bottom of the shield shall not extend below the spring line of the pipe without recompacting the pipe zone.
6. Cutting Pipe: When cutting or machining the pipe is necessary, the contractor shall use only the tools and methods recommended by the pipe manufacturer and approved by the Public Works Department authorized representative. The contractor shall cut ductile

iron pipe using a method approved by the Public Works Department authorized representative; all burrs or rough edges shall be removed before joining pipe. The contractor shall not flame-cut the pipe.

7. Transition Fittings: Connections of service branches to existing sewers shall be made watertight. Transition couplings between dissimilar pipe materials shall be made using approved commercial adapters with stainless steel bands such as Fernco, Caulder, or equal.
   (a) PVC couplers or adapters shall meet the specifications for ASTM D-3034, SDR 35 pipe fittings.
   (b) Ductile iron transition couplings shall be manufactured from ductile iron conforming to ASTM A-536, grade 65-45-12, for center and end rings. Rubber gaskets, bolts, and nuts shall conform to AWWA C-111/ANSI A21.11.
8. Concrete Closure Collars
   (a) The contractor shall pour closure collars against undisturbed earth, remove all water from the excavation, and construct suitable forms to obtain shapes that will provide full bearing surfaces against undisturbed earth, as indicated in these standards.
   (b) Closure collars shall be used only when approved by the Public Works Department authorized representative, and then only to make connections between dissimilar pipe, or where standard rubber-gasketed joints are impractical.
   (c) Before the closure collars are installed, the contractor shall wash the pipe to remove all loose material and soil from the surface where they will be placed.
9. Pipe Zone Material: The contractor shall install pipe zone material uniformly on both sides of the pipe, up to the spring line of the pipe. Material shall be placed in lifts not exceeding 6 inches. Material shall be well worked with hand tools to ensure proper support in the haunching area.
10. Line Taps
    (a) Line taps shall be core-drilled unless otherwise approved by the Public Works Department authorized representative. Core-drilled holes shall be made using a cylinder-style hole saw for plastic pipe material only, or a diamond core bit for concrete and ductile iron pipes.
    (b) Line tap connections to existing storm lines may be done using either saddle tees or by using Inserta Tee® as per Subsection 3.10.3, “Stormwater Pipe and Fittings”.
    (c) Line taps shall be centered on the spring line of the pipe being tapped.
    (d) The area around the saddle installation site shall be cleaned and free of all rough edges before installing the saddle.
    (e) While installing the saddle, no rock, dirt, or debris shall be allowed to enter the main sewer line from the core hole.
    (f) The contractor shall install ¾”-0” crushed aggregate in the pipe zone around the line tap, from 6 inches below the pipe to 12 inches above the pipe.
    (g) Laterals shall have tracer wire (12-gauge with white THNN insulation) installed beside the pipe.

3.11 CONSTRUCTION SPECIFICATIONS

3.11.1 General Provisions

The specifications outlined here, together with the standards established by the Oregon DEQ, the U.S. Environmental Protection Agency, and any other applicable requirements of the City, shall govern the character and quality of material, equipment, installation, and construction procedures for gravity-flow portions of public storm systems.

3.11.2 Scheduling

The contractor shall plan their construction work in conformance with Subsection 1.17.2, "Scheduling."

3.11.3 Environmental Protection, Erosion Prevention, and Sediment Control

The contractor shall take all appropriate measures and precautions to minimize the work's impact on the environment and shall control erosion, as outlined in Subsection 1.18, "Environmental Protection, Erosion Prevention, and Sediment Control."

3.11.4 Interferences and Obstructions

Various obstructions may be encountered during the course of the work. The contractor shall follow the guidelines established in Subsection 1.17.5, "Interferences, Obstructions, and Abandoned Utilities."

3.11.5 Contaminated Soil or Hazardous Materials

If during construction contaminated soil or with hazardous materials or chemicals are encountered, the Contractor shall follow the procedures specified in Subsection 1.18.2, "Contaminated Soils or Hazardous Materials."

3.11.6 Trench Excavation, Preparation, and Backfill

Trench excavation, preparation, and backfill shall conform to the requirements of Section 6, "Trench Excavation and Backfill Standards."

3.11.7 Preservation, Restoration, and Cleanup

a. Cleanup: Cleanup of all construction debris, excess excavation, and excess materials and complete restoration of all fences, mailboxes, ditches, culverts, signposts, and similar items shall be completed according to Subsection 1.17.16, "Preservation, Restoration, and Cleanup."
b. Preservation of Drainage Ditches: After backfilling the trenches, the contractor shall restore all public and private storm drain ditches that were destroyed, damaged, or otherwise modified during construction to the condition of the ditch before construction. Ditches shall be built in their original locations unless otherwise redesigned as part of the project.

3.11.8 Bores

a. General

   The carrier pipe in all bores shall be installed inside a steel case, unless otherwise approved by the City's authorized representative.

b. Installation
   1. Casing: The casing shall he smooth steel of a size to permit proper construction to the required line and grade. The steel casing shall be fabricated in sections for field-welded joints. The casing wall thickness shall he a minimum of/ inch for pipe diameters of 6 to 12 inches and shall be a minimum of 5/16 inch for pipe diameters of 15 to 24 inches, or in accordance with the requirements of the jurisdiction of the right-of-way.
   2. Pipe Supports: The sewer pipe shall be continuously supported on three sides by pipe supports, except at joints. Pipe supports shall be No. 2 HDPE plastic block or approved equal. Strapping and hardware shall be stainless steel.
   3. Placing Fill in Casing: The annular space shall be completely filled between the casing and pipe with lean grout or sand to prevent pipe flotation.
   4. Concrete Seals and Fill: After the storm pipe is tested and approved, concrete plugs shall be poured at each end of the casing. The annular space between the casing and pipe shall be completely filled with lean grout or sand to prevent pipe flotation.

c. Railroad Crossings

   Prior to beginning any under-track work, applicant shall obtain proper permit(s) from ODOT or present owner of railroad line and written approval of plans from user(s) of railroad line. Install the pipe by tunneling, jacking, boring or similar

methods, approved by the Railroad. Install the pipe to the lines and grades established and backfill completely all voids around the installation with specified material, to the satisfaction of the railroad.

3.12 TESTING PROCEDURES

3.12.1 General

a. The contractor shall furnish all necessary testing equipment and perform the tests in a manner satisfactory to the City's authorized representative.
b. All gravity storm systems shall be inspected and tested after backfill has passed the required compaction test(s) based on AASHTO T-180 and roadway base rock has been placed, compacted, and approved. All details of testing procedures shall be subject to approval of the City's authorized representative.
c. If repair work is required on a section of the system, that portion of the system shall be retested.
d. All testing shall be completed and accepted by the City's authorized representative before paving of overlying roadways will be permitted.

3.12.2 Line Cleaning

Before testing and City inspection of the system, the contractor shall ball and flush and clean all parts of the system. The contractor shall remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the system at or near the closest downstream manhole. If necessary, the contractor shall use mechanical rodding, bucketing or vactor equipment. When the City's authorized representative inspects the system, any foreign matter still present shall be flushed and removed from the system. Contractor shall provide screening; no material shall be flushed into the downstream city sewer system.

3.12.3 Deflection Test for Flexible Pipe

Storm systems constructed of flexible pipe shall be deflection-tested by pulling an approved mandrel through the completed pipeline. The diameter of the mandrel shall be 95% of the nominal pipe diameter, unless otherwise specified by the City's authorized representative. The mandrel shall be a rigid, nonadjustable, odd-numbered-leg (9 legs minimum) mandrel having an effective length of not less than its nominal diameter. Testing shall be done manhole-to-manhole and after the line is completely balled and flushed with water, and after compaction tests of backfill are completed and accepted. The contractor shall be required to locate and repair any sections that fail the test and to retest those sections. All repairs shall follow and be in compliance with the manufacturer's recommendations.

3.12.4 Video Inspection of Gravity Systems

All storm systems shall be video-inspected and approved prior to City acceptance. Video inspection shall take place after trench backfill and compaction has been completed and accepted, and channels have been poured in manholes. All pipes shall be thoroughly flushed immediately prior to the video inspection; only that water remaining from flushing shall be present in the system. The camera shall have the ability to tilt up to 90 degrees and rotate 360 degrees on the axis of travel. An inspection of all lateral connections shall be conducted using the tilt capabilities of the camera. A 1.0-inch target ball shall be placed in front of the camera. Observed sags must be less than 0.5 inch.
The City's authorized representative shall be notified and shall be present during video-inspection of the system, unless otherwise approved by the City's authorized

representative. A copy of the video and a written video inspection report, on a City-approved form, shall be supplied to the City's authorized representative. The video shall be recorded in color and in DVD or CD format. Video shall include a visual footage meter recording. Problems revealed during the inspection shall be noted on the video and in the written report. After repairs have been made, the line shall be re-inspected and re-tested. If excessive foreign material, in the opinion of the City's authorized representative, is encountered during video inspection, the line shall be balled and flushed, and re-video inspected.

3.13 WARRANTIES & ACCEPTANCE

3.13.1 Stormwater and Surface Water Acceptance Policy

The City of Molalla will accept new stormwater and surface water installations or systems built to the "Public Works Standards," providing that the following conditions are met.

a. Dedication of any required easements or rights-of-way have been recorded with the County Recorder and the Engineering Department receives a reproducible copy of the recorded documents.
b. After completion of construction of the total project, and after all testing has been satisfactorily completed, project closeout shall proceed as outlined in Subsection 1.17.17, "Project Closeout."
c. The Contractor or Applicant shall be responsible for providing Maintenance Assurance for Public Improvements as outlined in Subsection 1.17.18, "Maintenance Assurance and Warranty." Public storm improvements shall be warranted for a minimum of one year; public landscape improvements shall be warranted for a minimum of two years.
d. At any time during the warranty period, the City's authorized representative has reason to believe the public stormwater improvements have defects that were the result of faulty workmanship or flaws in construction material, the responsible party shall be required, at that party's own cost, to video-inspect the sewer line and repair any problems or faults revealed during video inspection by replacing those sections. The video inspection shall be done during the winter, if possible, or during the wet weather months, to identify all leaks.
e. Before the end of the Construction Maintenance period, the City's authorized representative shall inspect the project for any remaining deficiencies. If the deficiencies that remain are determined to be the responsibility of the contractor or the applicant, the contractor or applicant shall then make such repairs.
f. The Landscape Maintenance assurance shall be released two years after acceptance of construction, providing the landscaping meets the 90% survival level (see Subsection 3.13.2, “Landscape Inspection for Warranty”).

3.13.2 Landscaping Inspection for Warranty

a. The City's authorized representative shall inspect the condition of all landscaping located within the public right-of-way and/or the water quality/quantity facility at the end of the first year of the post-construction period. The City's authorized representative shall provide an interim inspection report to the applicant with a specific summary of any deficiencies. Failure of the City to provide the interim report shall not release the applicant from the responsibility for providing established landscaping at the end of the two-year landscaping maintenance period.
b. If at any time during the warranty period the landscaping falls below the 90% survival level, the applicant shall reinstall all deficient planting at the next appropriate planting opportunity. The two-year maintenance period shall begin anew from the date of replanting.

c. The 90% survival level shall meet the following criteria:
    1. In the opinion of the City's authorized representative, landscaping is established and healthy.
    2. Each plant group (trees, shrubs, herbaceous, and aquatics) shall meet the 90% survival level.
    3. Each p*l*anting zone (wet, moist, and dry) shall meet the 90% survival level.
d. Areal coverage shall meet the 90% survival level.

SECTION 4 – SANITARY SEWER DESIGN & CONSTRUCTION STANDARDS

4.1 ENGINEERING

4.1.1 Introduction

This chapter outlines design and construction requirements for all public sanitary sewers. The provisions and technical specifications herein set forth the requirements of the City of Molalla for constructing sanitary sewer improvements. Interpretations of such provisions and their application in specific circumstances shall be made by the Public Works Department authorized representative. Refer to Section 1 of the "Public Works Standards" for general provisions and requirements.

A map may be required that shows the drainage basin in which the project is located. The map shall show the major basin that is consistent with the City's current Wastewater Collection System Master Plan and any applicable amendments and updates to it.

4.1.2 General Provisions

Along with the provisions established in Subsection 1.14, "Control of Public Works Projects," all sanitary sewers shall be designed and constructed so as to conform to the requirements of the Oregon state plumbing laws and rules of the Oregon DEQ. Except as otherwise provided, the extension of the public sewerage facilities to serve any parcel or tract of land shall be done by, and at the expense of, the property owner, although the City reserves the right to perform the work or cause it to be performed and bill the owner for the cost of the work or to pursue special assessment proceedings. Public sewer extensions shall extend to the most distant parcel boundary, to facilitate future extension, unless otherwise approved by the Public Works Department authorized representative.

4.1.3 Extension of Public Sanitary Sewer

The extension or upsizing of the public sanitary systems to serve any parcel or tract of land shall be done by and at the expense of the property owner or permit applicant. The Public Works Department authorized representative may require a sewer pipeline that serves or may serve more than one property to be a public system.

4.1.4 Sanitary Plans

a. It is the design engineer's responsibility to ensure that engineering plans are sufficiently clear and concise to construct the project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill the intent of the design guidelines contained in these standards.
b. All elevation on design plans and record drawings shall be based on the applicable NAVD datum specified in Subsection 1.16.6, "Surveying and Land Monuments."
c. All engineering sanitary plans shall be stamped by a Professional Engineer registered in the State of Oregon. The sanitary plan shall contain the following:
    1. At least one sheet shall show a plan view of the entire project site. If the project site is sufficiently large that detailed sanitary plans on any given sheet do not encompass the entire project site, then a sheet showing the plan view of the entire site must serve as an index to subsequent detailed plan sheets.
    2. A topographic map showing existing conditions for the site, including the following:
        (a) Existing topography for the site.
        (b) Adjacent streets, including street names.

(c) Existing utilities, including franchised utilities located above or below ground. Existing drainage pipes, culverts, and channels shall include the invert or flow line elevations.
(d) Existing environmentally sensitive areas (e.g., ravines, swales, steep slopes, wells, springs, wetlands, creeks, lakes). For natural drainage features, show direction of flow, drainage hazard areas, and 100-year floodplain boundary (if applicable).

3. Plans for proposed sanitary improvements shall include the following:
   (a) Finished grades, showing the extent of cut and fill by existing and proposed contours, profiles, or other designations.
   (b) Proposed structures, including roads and road improvements, parking surfaces, building footprints, walkways, landscape areas, etc.
   (c) Proposed utilities, showing exact line and grade of all proposed utilities at crossings with the proposed sanitary system.
   (d) Applicable detail drawings.
   (e) Existing and proposed easements.
   (f) Setbacks from environmentally sensitive areas and protected natural resource areas.
   (g) Proposed sanitary structures.
   (h) Maintenance access, as applicable (see Subsection 3.4.4, "Access Road Design").
   (i) Plan and profile of sanitary systems, including the following information: pipe sizes, pipe types and materials, lengths, slopes, type of structure, location of structures, invert elevations in/out of structures, and top elevations of structures. Notes shall be included for referencing details, cross-sections, profiles, etc.
   (j) Any proposed phasing of construction.

4.1.5 Surveying

a. The design engineer shall be responsible for establishing the location of the sewer by means of reference stakes offset along the sewer. No construction shall be allowed to begin before construction staking. All staking shall be performed by or under the direction of a Professional Land Surveyor registered in the State of Oregon.
b. Stakes shall locate all public tees, cleanouts, manholes, water line crossings, and pump stations. Maximum spacing for reference stakes is 50 feet. Stakes shall reference cuts or fills to all invert elevations and rim grades. The design engineer shall also be responsible for identifying easements during construction.

4.1.6 Population Density

Population density figures shall be obtained from the most recent information available for use by the zoning or planning department of the City of Molalla. If those figures vary from those of the applicable master plan estimates, the difference must be noted in the design calculation.

4.1.7 Sewage Flow Determination

a. When required by the Public Works Department authorized representative, the design engineer shall prove to the City that all necessary methods of determining present and future capacity of the sanitary sewer have been considered. For flow variations and peaking factor, accepted flow design practice must be employed. A factor must be used, and the method used to obtain the factor must coincide with the method used in the City's Sanitary Sewer Master Plan. Infiltration and inflow must be represented in flow calculations in the design of the sanitary system.
b. Sewage flows must reflect any reasonably anticipated increase due to the development of the drainage basin upstream of the project being considered. Design engineers are cautioned not

to specify sewers of sizes that are obviously larger than necessary to achieve satisfactory carrying capacity, but which are specified to meet grade requirements.

4.1.8 Interceptor Required

Grease, oil, and sand interceptors shall be required when, in the opinion of the Public Works Department authorized representative or Building Official, they are necessary for the proper handling of wastewater containing fats, wax, grease, sand, or oils, whether emulsified or not, and containing any products or substances that may solidify or become viscous at temperatures of between 32° and 150°F (0° to 65°C). Any discharger of such wastewater shall be required to install, use, maintain, and keep in good working condition an interceptor. See Definitions.

4.1.9 Interference with City Sewer System Prohibited

No person shall block, obstruct, or interfere with any portion of the City sanitary sewer system without a plan being submitted and approved by the Public Works Department authorized representative. This prohibition includes, but is not limited to, the obstruction of the flow of sewage from, and to any point within, the City sewer system.

4.2 SANITARY MANHOLE AND PIPE DESIGN STANDARDS

4.2.1 Manhole Design

a. Manholes shall be provided at least every 400 feet, unless otherwise approved by the Public Works Department authorized representative. Manholes shall be located at every grade change, change in pipe size, and change in alignment. Manhole lids shall be centered in the roadway as indicated in the street detail drawings of these standards unless an exception is approved by the Public Works Department authorized representative.
b. When a manhole is 5 feet or less deep, a flat-top or shallow manhole shall be used. Flat-top manholes shall be designed to be installed at an elevation to permit construction of the full street section, allowing for the design gradients.
c. All manholes shall be a minimum of 48 inches in diameter for pipe sized up to 18-inches diameter, minimum 60-inch diameter manhole for 18-inch to 30-inch pipe diameter, and minimum 72-inch manhole for 30-inch and larger pipe diameter.
d. Suburban style manholes frames shall not be used in PCC streets.
e. There shall be a maximum of 4 pipes entering/exiting a manhole unless otherwise approved by Public Works Department authorized representative.
f. Detail(s) shall be submitted with the plans where pipes into or out of a manhole are larger than 24 inches or where more than four mainline connections are made. The manufacturer or design engineer shall provide the Public Works Department authorized representative with supporting calculations, stamped by a Professional Engineer registered in the State of Oregon, documenting the structural integrity of the manhole.
g. Connections to an existing manhole, elevation of the existing ledge, location of steps, and elevations of existing inlets and outlets shall be submitted with the plans.
h. All precast manhole bases shall have smooth, clean openings at the design inlets and outlet points. Openings shall not be saw cut or broken out.
i. All manhole bases shall be properly channelized. No more than three side laterals are allowed to be connected to a manhole, unless an exception is approved by the Public Works Department authorized representative. There shall be a minimum of 8 inches separating connections, measured from the outside diameter of the core holes.
j. All manholes shall have inlets at a minimum 90-degree angle in relation to the outlet, as measured from the center of the manhole base.
k. Manholes shall have a minimum freefall of 0.10 feet and a maximum freefall of 1.5 feet.

l. Drop manholes: The maximum inside drop in a manhole shall be 18 inches. When more than 18 inches of drop exists, an outside drop manhole shall be used. Outside drops shall be constructed of ductile iron pipe.

4.2.2 Sanitary Pipe Design

a. Pipe size: No public sanitary sewer shall be less than 8 inches in diameter, unless otherwise specified by the Public Works Department authorized representative. Side sewers shall be either 6-inch or 4-inch inside diameter, as required by the City. All side sewer pipes shall be polyvinyl chloride (PVC) and shall conform to ASTM D-3034.
b. Location: Sanitary sewers, wherever possible, shall be installed near the centerline of the public right-of-way. Sanitary pipe shall be located not closer than 5 feet to face of curb, unless an exception is approved by the Public Works Department authorized representative. In any event, all sewer locations shall be approved by the Public Works Department authorized representative.
c. Easements: When it is not possible or practical to install the sewer line in a dedicated public street, a minimum 15-foot public pipeline easement shall be provided. Sewer lines shall be located in the center of the easement, unless an exception is approved by the Public Works Department authorized representative. The centerline of the pipe shall be at least 7½ feet from an easement side line.
d. Alignment: Public sanitary pipe shall be laid on a straight alignment and at uniform grade, unless an exception is approved by the Public Works Department authorized representative.
e. Connections: Lateral connections on new construction work shall be done using manufactured tees installed at surveyed locations. Lateral connections to existing sanitary lines may be done using either saddle tees or by using Inserta Tee® as per Subsection 3.10.3, "Stormwater Pipe and Fittings". Laterals shall be of same material as main. The lateral shall be no larger than 50% the diameter of the main line, unless otherwise approved by the Public Works Department authorized representative.
f. Laterals: Sanitary laterals shall be provided with a cleanout installed at the public right-of-way or easement. Cleanouts shall not be installed in the driveway or sidewalk, unless approved by the Public Works Department authorized representative.
g. Curb Marking: Newly constructed curbs or replaced curbs shall be stamped with the capitol letter "S" at the location of each sanitary lateral crossing. Letters shall be 3 inches in height and embossed a minimum of ⅛-inch deep.
h. Locating Wire and Tape: Sanitary mains and laterals shall have tracer wire (12-gauge with green THNN insulation) installed beside the pipe. Surface locating wire at right-of-way cleanouts; tape shall be tied off to the 2 x 4 marker.
i. Grade: All sanitary sewers shall be laid on a grade that will produce a mean velocity of at least 2 feet per second when flowing full or half-full. The minimum grades for various sizes of pipe are listed in **Table 4.1**.

Table 4.1. MINIMUM GRADIENT FOR SANITARY SEWERS

Inside Pipe Diameter (inches)	Grade (%) (feet per 100 feet)
Sanitary Laterals	
4	1.00
6	0.60
Sanitary Mains	
8	0.40
10	0.28
12	0.22
15	0.15
18	0.12
21	0.10
24	0.08
27	0.07
30	0.06

j. Steep Slopes: Sewers pipes on slopes in excess of 20% gradient shall be secured with approved concrete anchor walls. Spacing for anchors shall be as shown in **Table 4.2**.

Table 4.2. SECURING SEWERS ON SLOPES

Minimum Anchor Spacing Sewer Gradient >20%	
Grade (%)	**Center to Center (feet)**
<35	35
35-50	25
>50	15 (or concrete encasement)

k. Pipe Cover: All sanitary sewers shall have a minimum of 5 feet of cover over the top of the sewer pipe to finish grade. When such minimum cover is not possible, pipe cover shall meet the requirements in **Table 3.15**.

l. Sewer in Vicinity of Water Supplies: No existing or proposed pressured sanitary sewer shall be permitted within 100 feet of any well, spring, or other source of domestic water supply. No existing or proposed gravity sewer line shall be permitted within 50 feet of any well, spring, or other source of domestic water supply.

m. Water and Sewer Lines:
   1. Sanitary sewers and domestic water lines shall not be laid in the same trench. Parallel water and sewer lines shall be at least 10 feet apart horizontally and meet Oregon DEQ separation requirements.

2. When there is less than 18 inches of vertical clearance between water and sewer, and when physical conditions render that spacing impossible or impractical, then class 50 ductile iron pipe with watertight joints, C-900 PVC pipe, concrete encasement, or pipe approved by the Public Works Department authorized representative shall be required.
3. Wherever it is necessary for sewer and water lines to cross each other, the crossing shall be at an angle of approximately 90 degrees. The sewer line shall be located 18 inches or more below the water line or shall be constructed of pipe material approved by the Public Works Department authorized representative for a distance of 10 feet on both sides of the water line.

4.2.3 Access

Access roads are for maintenance and inspection purposes. All-weather access shall be provided to every manhole. Access roads shall be constructed as per Subsection 3.4.4, "Access Road Design."

4.3 PUMP STATION DESIGN

4.3.1 General Provisions

a. Applicability: These standards are applicable to the construction, installation, or modification of any wastewater pump station system requiring a City of Molalla Public Works Permit.
b. Scope: In order to accomplish the orderly and desirable development of land within the corporate limits of the City and to limit the costs associated with the operation and maintenance of wastewater pump stations borne by the City, the Public Works Director deems it reasonable and necessary to restrict the installation of wastewater pump stations. Therefore, wastewater pump stations will not be allowed in areas: where gravity sewer service is programmed for construction in an applicable capital improvement plan, where improvements are recommended in the City of Molalla Wastewater Collection System Master Plan, or where sewers are available within three thousand (3,000) feet.
Temporary pump stations will be allowed in areas where future development will require extension of gravity sewers and the Public Works Department authorized representative determines that the temporary station is economically justified. Design life must be less than ten (10) years, as determined in the preliminary engineering report, and have a capacity of less than four hundred (400) gallons per minute (GPM).
Permanent pump stations will be allowed in areas where future development does not require extending gravity sewers, as determined in the preliminary engineering report and the applicable, if any, master plan for the area.
c. Variance: When engineering justification satisfactory to the Public Works Department authorized representative is provided substantially demonstrating that variation from the design standards or siting criteria will result in either: at least equivalent effectiveness while significantly reducing costs, or improved effectiveness, such a variation from design standards or siting criteria may be accepted by the Public Works Department authorized representative.
d. Reviewing Authority: The Oregon Department of Environmental Quality is the final reviewing authority. All plans and specifications for a wastewater pump station shall be reviewed and approved by the Oregon Department of Environmental Quality (DEQ). The basis for review by DEQ review engineers is Oregon Administrative Rule 340 Division 52 (OAR 340-52), Review of Plans and Specifications. To that extent, all plans and specifications shall follow the guidelines and criteria set forth in the current version of the Oregon Standards for Design and Construction of Wastewater Pump Stations. The standards in this

Wastewater Pump Station Design Standards chapter of the Public Works Standards are developed as supplemental standards to address local needs, preferences, and existing equipment. Conflicts between the City's established standards and DEQ guidelines shall be resolved by first following that standard or guideline which is more stringent and/or specific; second, by determination of the Public Works Department authorized representative as to which standard or guideline is in the best interests of the City.

4.3.2 General Requirements

a. Administration: The design engineer in charge must be registered in the State of Oregon and have had previous experience designing similar facilities, including mechanical, electrical, telemetry, and control systems. The engineer's qualifications shall be submitted prior to initiation of study and shall be acceptable to the Public Works Department authorized representative. An authorized representative of the City will be available for construction observation during construction of the project. The design engineer of the pump station shall provide startup services. Provisions for maintenance of temporary pump stations may be required.
b. Flood Protection: The station's electrical and mechanical equipment, which would be permanently damaged by flooding, shall be located at an elevation that is not subject to a 100-year flood or shall otherwise be adequately protected against damage from the 100-year flood. The station shall be designed to remain operational and accessible during the 25-year flood. In the absence of official records to establish 100-year and 25-year flood elevations, the best available local information shall be used.
c. Siting: Pump stations shall be located as far as practical from present or proposed built-up residential areas and off the traffic way of streets and alleys. Noise control, odor control, station architectural design and other aesthetic items shall be taken into consideration and reviewed by the Public Works Director. Sites for stations shall be of sufficient size for future expansion or addition, if applicable.
d. Safety: It is the design engineer's responsibility to ensure that the OSHA, the National Electrical Code, and all other applicable building and construction codes and requirements are met during construction. Adequate provision shall be made to protect construction and, subsequently, maintenance and operation personnel from hazards. Equipment and training for confined space entry in accordance with OSHA and regulatory agency requirements shall be provided for all wastewater pumping stations.

4.3.3 Preliminary Engineering Report

A preliminary engineering report prepared by the design engineer as a basis for design for all wastewater pumping stations shall be submitted to the Public Works Department authorized representative for review and approval. The preliminary engineering report shall include, but is not limited to, the following information:

a. Service Area Study
    1. Population: Present and future population and/or industrial/commercial usage projections. Present, design and ultimate flows of all areas that could be served.
    2. Land Use: Type of land use, zoning and comprehensive plan designations.
b. Design Characteristics
    3. Average and peak flow calculations, unit flows and peaking factors and infiltration/inflow allowances for present and future design conditions.
    4. Wet well configuration and size.

5. Number, type, capacity, motor horsepower and Net Positive Suction Head (NPSH) requirements of proposed pumping units. Motor shall be protected from over-current, over-temperature and voltage imbalance. Pumping units shall be duplex.
6. System head curve and head computations for design conditions of pumping system. (Future pumping capacity requirements shall be considered in sizing pumping equipment.)
7. System head calculations shall include the size and length of force main static head, all dynamic losses and assumed "c" (friction) factor. Force main shall be a minimum of four (4) inch diameter.
8. Calculations showing flotation potential and ballasting, if necessary.
9. Description of primary and back-up power sources. All wastewater pump stations shall be supplied with a back-up or alternate power source.
10. Other hydraulic computations shall include, but not limited to, pump cycling time, wet well capacity, flushing velocity and surge analysis.

c. Preliminary Plans

Shall be in conformance with Subsection 4.1.4, "Sanitary Plans," and, in addition, shall show the following:

1. A contour map of the proposed site, service area, and force main.
2. Proposed pump station, including structure, site layout, landscaping street connection, and provisions for future pumps, if necessary.
3. Existing pump station, if applicable.
4. The 100-year flood plain elevation at the site.
5. Maximum elevation of wastewater in the collection system and wet well in the event of a power failure for the estimated duration of the power outage.
6. Worst-case overflow drainage pattern and receiving stream.
7. Process and Instrumentation diagrams for electrical and control systems.
8. Force main with both plan and profile views to the connection at the receiving location.

4.3.4 Design Criteria

a. General

1. The pump station shall be designed to maintain the liquid level of a wet well by automatically starting and stopping pumping operation as required by wet well conditions.
2. The pump station shall have a firm capacity to pump the peak hourly and peak instantaneous flows associated with the 5-year, 24-hour storm intensity (see **Table 3.2.** Rainfall Distribution) of its service area, without overflows from the station or its collection system.
3. Design shall be consistent with EPA Class I reliability standards for mechanical and electrical components and alarms.
4. Pumping systems shall be duplex with pump sequencing and each pump sized in excess of the expected maximum flow.
5. Above ground pump stations shall be required unless otherwise approved.
6. The wet well shall have sufficient volume to provide a holding period of 10 minutes between pump operating cycles at maximum design pump station flow. The floor shall be sloped for proper installation and function of the pumps inlets. Influent flow shall enter the wet well above the pump operating level.
7. All-weather access for vehicles shall be provided. The site shall be fenced, and the fence shall be six feet high. Landscaping shall be provided that adequately obscure the site from view.

8. A remote telemetry unit shall be installed and integrated with the city's programmable logic controller/SCADA system. Local control shall be provided in case of telemetry failure. All appropriate alarms shall be wired and tested for accuracy before they are accepted.
9. The pump station shall be provided with potable water for wet well wash down. Water shall be metered, at or above finish grade and provided with a reduced pressure (RP) backflow device (If outside, a heated enclosure for the RP shall be supplied.)
10. Sufficient back up power to operate the station in case of power outage shall be supplied.
11. Exterior and interior lighting and convenience outlets shall be provided.
12. Adequate piping, valves, and appurtenances for isolation and removal of equipment shall be provided. Capability for bypass pumping shall be provided.
13. Pumps shall be sized to pass a minimum of a three-inch sphere. Pump suction, discharge, and force mains shall be at least four inches diameter.
14. Suitable shutoff and check valves shall be placed on the discharge line of each pump. The check valve shall be located between the pump and the shutoff valve. Check valves shall be suitable for the material being handled and shall be placed on the discharge line in a horizontal position. All shutoff and check valves shall be operable and accessible from floor level. Swing check valves shall have outside levers.
15. Federal and State OSHA regulations and guidelines, and any other relevant state, federal and local safety regulations and guidelines shall be followed and adhered to.

b. Above Ground Pump Station
    1. The above ground pumping station shall be an enclosure housing a duplex, skid mounted, auto-start station utilizing two electric-motor driven, self-priming centrifugal pumps, motor control panel, system piping, two level control systems and a natural gas standby engine (in addition to back-up electric power.). The pump station shall be a Gorman-Rupp base mounted package pump station.
    2. A load-test-certified electric hoist and trolley, or approved equal, shall be provided in the pump room. Overhead crane hoist and other installed equipment shall have adequate horizontal and vertical clearance to allow for lifting and moving motors and pump equipment to the station doors using the monorail.
    3. The level control system shall consist of a duplex pump air bubbler wastewater level sensing system with a backup submersible pressure transducer or ultrasonic level sensor. Provision shall be made to automatically/manually alternate the bubbler air pumps. The level control system shall be capable of sensing and activating controls at four wet well levels.
    4. The pump station enclosure shall be supplied with adequate ventilation and a thermostatically controlled electric heater. The heater shall be sufficient to prevent the freezing of the pumps and piping within the pump station enclosure at an outside temperature of minus twenty (20) degrees F.
    5. The pump equipment compartment shall be above grade or offset and effectively isolated from the wet well to prevent humid and corrosive wastewater gases from entering the equipment compartment.
    6. Wet well access shall not be through the equipment compartment.
    7. Valving shall not be located in the wet well.
c. Submersible Pumps
    1. Submersible pumps and motors shall be designed specifically for wastewater use, including totally submerged operation during a portion of the pump cycle.

2. Submersible pumps shall be readily removable and replaceable without de-watering the wet well or disconnecting any piping in the wet well.
3. Valves for submersible pumps shall be located in a separate valve chamber. Accumulated water shall drain to the wet well. Wastewater and gases from the wet well shall be prevented from entering the valve chamber.
4. Electrical supply, power, control, alarm circuits, and lines shall be designed to provide strain relief and to allow for disconnection and de-energizing outside the wet well. Terminals and connectors shall be protected from corrosion by location outside the wet well. All penetrations of the wet well shall be watertight. All conduits shall be sealed to prevent gases from entering outside cabinets and equipment from the wet well.
5. The motor control center shall be located outside of the wet well and protected by conduit seals to prevent gases from the wet well from entering the control cabinet.
6. A stainless-steel rail and mounted hoist shall be provided for access to and servicing of the pumps and backup-generator or motor.

4.3.5 Operation and Maintenance Manual

Three copies of an operation and maintenance manual shall be provided and shall contain the following information:

a. Component description, with both simplified and detailed system schematics.
b. Operation information, including startup, normal, and emergency operation and instructions on common problems.
c. Maintenance information, including records, lubrication, and scheduling requirements and information on local representatives.
d. Safety.
e. Manufacturers' manuals.

4.4 MATERIAL AND TECHNICAL SPECIFICATIONS

4.4.1 Manholes and Structures

a. General
Manholes shall be constructed at locations shown on the plans, or as required by the Public Works Department authorized representative. The maximum distance between manholes shall be 400 feet, unless otherwise approved by the Public Works Department authorized representative. All manholes shall be a minimum of 48 inches in diameter. When a manhole is less than 5 feet deep, a shallow or flat-top manhole shall be used. Flat-top manholes shall be installed at an elevation to permit for construction of the full street section, allowing for the design gradients.

b. Materials
1. Aggregate and Cement: Aggregate shall meet the standards set forth in ODOT SSC Section 02690, "PCC Aggregates"; Portland cement shall meet the standards set forth in ODOT SSC Section 020, "Portland Cement."
2. Concrete: PCC for poured in place manholes and structures shall conform to ODOT Class 3000 – 1½, Commercial Grade Concrete. Slump shall be between 2 and 4 inches.
3. Manhole Frames and Covers:
   (a) Casting shall be of new material, tough, close-grained gray iron conforming to ASTM A-48, Class 30, and shall be smooth and clean, free of blisters, blowholes, and all defects. Bearing surfaces shall be planed or ground to ensure flat, true surfaces. Covers shall be true and set within rings at all points.
   (b) Rings shall be grouted in place and made watertight with a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as

Alcrete Twenty Minute Fast Setting Grout® or approved equal. Unused grout shall be discarded after 20 minutes and shall not be used. Rings shall not be brought to grade with lumber.

(c) Frames and covers shall be standard or suburban, depending on the manhole location and as approved by the Public Works Department authorized representative. Suburban style manhole frames shall not be installed in PCC streets.

(d) Manholes installed outside of paved street or sidewalk areas shall be installed with a tamperproof frame and cover.

4. Manhole Types: Manholes shall be one of the following types or equal.

(a) Precast 48-Inch-Diameter Manholes: Materials shall conform to the requirements of ASTM C-478. Minimum wall thickness shall be 5 inches. Cones shall be eccentric. Before precast manhole sections of any size are delivered to the job site, the sections shall meet the permeability test requirements of ASTM C-14.

(b) Precast Large-Diameter (60-inch or larger) Manholes: Materials shall conform to the requirements of ASTM C-478.

(c) Cast-in-Place Large-Diameter Manholes: Aggregate shall meet the standards set forth in ODOT SSC Section 02690, "PCC Aggregates"; Portland cement shall meet the standards set forth in ODOT SSC Section 020, "Portland Cement."

(d) Precast Bases: Precast base sections or manhole bases shall be used, except over existing pipe, where poured-in-place bases shall be used. Precast manhole bases shall be inspected and approved by the Public Works Department authorized representative prior to installation. Where precast bases are not channelized, the contractor shall construct smooth channels to connect the flow from inlet pipe(s) to outlet pipe.

(e) Concrete Bases (Poured-in-Place): Poured-in-place bases shall be used over existing pipelines. The contractor shall remove water from the excavated area, provide a minimum 8-inch-thick layer of compacted ¾"-0" crushed aggregate for a base, and construct the concrete base so that the first precast manhole section has a uniform bearing throughout the full circumference. There shall be a minimum of 8 inches of concrete between the compacted gravel and the lowest invert of the manhole. The contractor shall deposit sufficient concrete on the base to assure a watertight seal between base and manhole wall. Twenty-four hours shall be allowed to elapse before the remaining manhole sections are placed on the base, unless otherwise approved by the Public Works Department authorized representative.

5. Pipe Stub-outs for Future Sewer Connections: Pipe stub-outs shall be the same type as approved for use in the lateral, main, or trunk sewer construction. Strength classifications shall be the same class as in adjacent trenches. Where two different classes of pipe exist at a manhole, the higher-strength pipe shall govern strength classification. Connect stub-outs to manholes as specified in this Subsection in "Connection to Existing Manholes." Rubber-gasketed, watertight plugs shall be furnished with each stub-out and shall be adequately braced against air test pressures.

6. Gaskets: Manhole sections shall be installed with either preformed rubber gaskets or plastic gaskets. Rubber gaskets shall conform to ASTM C-443. Plastic gaskets shall be Kent-seal No. 2 or Ram Neck, or approved equal, and shall meet all requirements of ASTM C-990.

7. Manhole Steps: Steps shall be required and shall be constructed as specified in these standards, unless otherwise approved by the Public Works Department authorized representative. When pipe is 24 inches in diameter or smaller, steps shall be located as indicated in these standards. For pipe larger than 24 inches in diameter, steps shall be

located over a bench as coordinated with the Public Works Department authorized representative. Maximum drop from rim to first step shall be 27 inches.

c. Workmanship
    1. Foundation Stabilization: If, in the opinion of the geotechnical engineer or the Public Works Department authorized representative, unstable subgrade material exists that will not support the manhole or other structure, the contractor shall excavate below grade and backfill with foundation-stabilization material approved by the Public Works Department authorized representative.
    2. Pipe Connections: All rigid pipes entering or leaving the manhole shall be provided with flexible joints within 1 foot of the manhole structure and shall be placed on firmly compacted bedding. Special care shall be taken to see that the openings through which pipes enter the structure are completely watertight. All flexible pipe shall be connected to manholes according to the manufacturers' recommendations.
    3. Flexible Joints: Where the last joint of the line laid up to the manhole is more than 1 foot from the manhole base, a 6-inch concrete encasement shall be constructed around the entire pipe, from the manhole base to within 1 foot of the pipe joint, at the discretion of the Public Works Department authorized representative. The pipe encasement shall be constructed integrally with the manhole base. Pipes laid out of the manhole shall be shortened to ensure that the first flexible joint is no more than 1 foot from the manhole base.
    4. Manhole Connections: The contractor shall connect sewer pipe to manholes as specified in this Subsection in, "Types of Connections."
    5. Drop Manholes
        (a) The maximum inside drop in a manhole shall be 18 inches. See "Shallow Inside Drop Manhole," for construction of this connection.
        (b) When more than 18 inches of drop exists, an outside drop manhole shall be used. Outside drop manholes shall use ductile iron pipe.
    6. Placing Manhole Section: The contractor shall clean the end of each sections of foreign material. Manholes shall be installed with either watertight rubber O-rings or preformed plastic gaskets in conformance with the manufacturers' recommendations. If plastic gaskets are used, the inside seams shall be grouted with a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout® or approved equal. Unused grout shall be discarded after 20 minutes and shall not be used. Manholes will be visually inspected for water leakage by the Public Works Department authorized representative. Any leakage observed shall be repaired at the contractor's expense, and the manhole re-inspected.
    7. Manhole Inverts: The contractor shall construct manhole inverts in conformance with these standards. Inverts shall have smooth transitions to ensure an unobstructed flow through the manhole. The contractor shall remove all sharp edges or rough sections that tend to obstruct flow.
    8. Manhole Stub-outs: The contractor shall install stub-outs from manholes for sewer extensions, as shown in these standards or as required by the Public Works Department authorized representative. A watertight flexible connection shall be used for pipe sizes 6 inches through 18 inches in all new manholes. The contractor shall construct invert channels in accordance with these standards. The minimum length of stub-outs in existing manholes shall be 12 inches outside the manhole wall. Pipes shall be grouted in precast walls or the manhole base to create a watertight seal around the pipes. The contractor shall install compacted base rock, as specified in these standards, to undisturbed earth under all stub-outs.

9. Manhole Extensions, Rings, and Covers: The contractor shall install rings and covers on top of manholes to positively prevent all infiltration of surface water or groundwater into manholes. Rings shall be set in a bed of high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal, with the grout carried over the flange of the ring, and shall be set so that tops of covers are flush with the surface of the adjoining pavement, or 1 foot above the natural ground, unless otherwise directed by the Public Works Department authorized representative. Unused grout shall be discarded after 20 minutes and shall not be used. Total thickness of grade rings shall not exceed 12 inches; rings shall be grouted watertight. Drop from rim to first manhole step shall not exceed 27 inches. In designated floodplain areas, all manholes shall be at an elevation of at least 2 feet greater than the 100-year storm event.

d. Types of Connections
   1. Connection to Existing Manholes: The contractor shall connect sewers to existing manholes at the locations shown on the plans. Contractor shall submit a plan for diversion control and receive written approval from the Public Works Department authorized representative before proceeding with construction. The contractor shall provide all diversion facilities and shall perform all work necessary to maintain sewage flow in existing sewers while connections are being made to the manholes. Connections to existing manholes shall be core-drilled, and the bases shall be grouted as necessary to allow a smooth flow into and through the existing manholes.
   2. Manholes over Existing Sewers: The contractor shall construct manholes over existing operating sewer lines at the locations shown on the plans. The contractor shall construct a poured-in-place base under the existing sewer and the precast sections as specified. The contractor shall not cut into any existing lines until the new manhole(s) are grouted and pressure tested, the new lines are balled, flushed, deflection tested, and pressure tested, and all portions of the sewer have been approved and accepted by the Public Works Department authorized representative. After acceptance, the contractor shall saw cut into the existing line; cut edges of concrete pipe shall be covered with grout and troweled smooth; with ductile iron or plastic pipe, grout shall be applied up to cutout and troweled smooth.
   3. Shallow Inside Drop Manhole: Where the invert of the connecting pipe is above the manhole shelf and less than 18 inches above the outlet, an inside drop shall be constructed utilizing Portland cement concrete. The sewage entering the manhole shall follow a smooth concrete channel transitioning evenly from the invert of the inlet pipe into the main channel. Sewage shall not be allowed to fall freely to the manhole base.

4.4.2 Gravity Sewer Pipe and Fittings

a. General
   Sanitary sewer pipe shall have flexible gasket joints. Joints on all fittings shall be the same as the joints used on the pipe. Caps or plugs shall be furnished with each fitting, outlet, or stub, as required, and shall have the same type of gasket or joint as the pipe.

b. Materials
   Materials shall be the following types or approved equal:
   1. Concrete Pipe (NRCP/RCP)
      (a) Non-reinforced concrete pipe shall conform to requirements of ASTM C-14. Unless otherwise specified, pipe shall conform to Class 3 design requirements.
      (b) Reinforced concrete, non-pressure pipe shall conform to the requirements of ASTM C-76 or C-655 and shall be of the class specified. Unless otherwise specified, pipe

shall meet the design requirements of Wall B. Reinforced concrete low-head-pressure pipe shall conform to the requirements of ASTM C-361.

(c) Gaskets shall conform to the requirements of ASTM C-443.

(d) All steam-cured concrete pipe must be at least seven days old before it can be used. If the pipe has not been steam-cured, it must not be used before it has cured for 28 days.

(e) Fittings shall be manufactured integrally and be of a class at least equal to that of the adjacent pipe. Field taps shall be machine-drilled.

(f) Mortar used shall be standard non-shrink premixed mortar conforming to ASTM C-387 or in a proportion of one-part Type II Portland cement to two parts clean, well-graded sand that will pass a ⅛-inch screen. Mortar mixed for longer than 30 minutes shall not be used.

2. Ductile Iron Pipe (D.I.)

(a) Ductile iron pipe shall conform to the requirements of AWWA C-151/ ANSI A21.51, cement lined push-on joint. The minimum thickness class shall be Class 50 (up through 12-inch diameter pipe) and Class 51 (for 14-inch diameter and larger pipe).

(b) Fittings shall be mechanical or push-on. Mechanical joint ductile iron fittings shall conform to AWWA C-110. Push-on joint fittings shall be gray iron, with body thickness and radii of curvature conforming to ANSI A-21.10. Rubber gasket joints shall conform to AWWA C-111/ ANSI A-21.11.

3. Plastic Pipe

(a) Plastic pipe shall have a minimum stiffness of 46 psi as determined by ASTM D-2412.

(b) Polyvinyl Chloride Pipe (PVC) pipe shall conform to the applicable portions of the following specifications: ASTM D-3034 (SDR 35 or lower), ASTM D-1784, ASTM D-1785, ASTM F-679, ASTM F-794, AWWA C-900, AWWA C-905, and AWWA C-906.

(c) PVC fittings shall conform to the applicable portions of the following specifications: ASTM D-3034, ASTM D-1785, ASTM D-2466, and ASTM D-2467. Fitting joints shall be the same as the pipe joints. Threaded connections shall conform to the requirements of ASTM D-2464 for schedule 80 pipe.

4. Fittings

(a) General

(1) Manufactured tee fittings shall be provided in the sewer main for side sewers. Fittings shall be of sufficient strength to withstand all handling and load stresses encountered.

(2) Fittings shall be of the same materials as the pipe. Material joining the fittings shall be of the same material as the pipe.

(3) Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface.

(4) All fittings shall be capped or plugged and shall be gasketed with the same gasket material as the pipe joint, fitted with an approved mechanical stopper, or have an integrally cast knockout lug. The plug shall be able to withstand all test pressures without leaking. When later removed, the plug shall permit continuation of piping with jointing similar to joints in the installed line.

(5) Mechanical Couplings: Mechanical couplings shall be wrought steel. Installation procedures must meet the manufacturers' recommendations.

5. Line Tap Saddle

(a) PVC Tee Saddle: manufactured in accordance with ASTM D-3034 with minimum cell classification of 12454B-C or 12364-C as defined in ASTM D-1784. Elastomeric seals shall meet ASTM F-477 specifications; locate seals at both the lead and skirt ends of

the saddle. Saddles shall be banded to pipe with #316 Stainless Steel bands, 9/16-inch wide. This saddle is allowed on PVC, clay, IPS, concrete, asbestos cement, and PE pipe.

(b) Romac Style "CB" Saddle shall be made of casting of ductile iron, which meets ASTM A-536, grade 65-45-12. Rubber gaskets shall conform to AWWA C-111/ANSI A21.11. The band shall be stainless steel with Teflon coated nuts and bolts. This saddle is not allowed on plastic pipe except C-900.

(c) Inserta Tee® or approved equal: hub adaptor shall be manufactured in accordance with ASTM D-3034; elastomeric seals shall meet ASTM F-477 specifications. This connection is allowed only on thick wall pipe material, e.g., concrete, ductile iron, rib type plastic. Connection point shall be core drilled. Hole diameter shall be cut to manufacturer's specifications. Hub adaptor shall be connected to rubber sleeve with #316 Stainless Steel band (9/16-inch wide), screw, and housing. Inserta Tee® connection shall have a gasketed bell for use with sanitary sewers.

c. Proof Tests

The intent of this requirement is to prequalify a joint system, components of which meet the joint requirements, as to the water tightness capability of the joint system. The proof test shall be understood to apply to sanitary sewers that are to be tested for water tightness before acceptance. Material and test equipment for proof-testing shall be provided by the manufacturer. When approved, internal hydrostatic pressure may be applied by a suitable joint tester. Each pipe material and joint assembly shall be subject to the following three proof tests, at the discretion of the Public Works Department authorized representative:

1. Pipe in Straight Alignment: No less than three or more than five pipes selected from stock by the Public Works Department authorized representative shall be assembled according to the manufacturers' installation instructions, with the ends suitably plugged and restrained against internal pressure. The pipe shall be subjected to 10-psi hydrostatic pressure for 10 minutes. Free movement of water through the pipe joint wall shall be grounds for rejecting the pipe.
2. Pipe in Maximum Deflected Position: A test section is described below for each pipe material. The pipe shall be subjected to 10-psi hydrostatic pressure for 10 minutes. Free movement of water through the pipe joint or pipe wall shall be grounds for rejecting the pipe.
3. Joints under Differential Load: The test section shall be supported on blocks or otherwise, as described below for each pipe material. There shall be no visible leakage when the stressed joint is subjected to 10-psi internal hydrostatic pressure for 10 minutes.
   (a) Concrete Pipe: For a deflected position, a position ½ inch wider than the fully compressed position shall be created on one side of the outside perimeter. For a differential load, one pipe shall be supported so that it is suspended freely between the adjacent pipe, bearing only on the joints. In addition to the weight of the suspended pipe, a test load shall be added, as shown in **Table 4-3**.

Table 4.3. TEST LOADS FOR CONCRETE PIPES UNDER DIFFERENTIAL LOAD

Pipe Size (inches)	Load per Foot, Laying Length Up to 4 Feet (pounds)	Total Load, Pipe 4 Feet and Over (pounds)
Sanitary Laterals		
4	650	2,600
6	1,000	4,000
Sanitary Mains		
8	1,300	5,200
10	1,400	5,600
12	1,500	6,000
15	1,850	7,400
18	2,200	8,000
21	2,500	10,000
24 and over	2,750	11,000

(b) Ductile Iron Pipe: For the deflected position, a position ½ inch wider than the fully compressed section shall be created on one side of the outside perimeter. For a differential load, one of the pipes shall be supported so that it is suspended freely between the adjacent pipe and bearing only on the joints. A force shall be applied along a longitudinal distance of 12 inches beside one of the joints, as specified in **Table 4-4**.

Table 4.4. TEST LOADS FOR DUCTILE IRON PIPES UNDER DIFFERENTIAL LOAD

Pipe Size (inches)	Load (pounds)	Pipe Size (inches)	Load (pounds)
4	600	15	3,700
6	900	18	4,400
8	1,200	21	5,000
10	1,500	24 and over	5,500
12	1,800	--	--

(c) PVC Pipe: For the deflected position, two 12½-foot lengths shall be joined, then deflected along an arc of 720-foot radius (0.11 feet offset at the end of each length from a tangent at the joint). For a differential load, two lengths shall be joined and uniformly supported for at least 2 feet on both sides of the joint and the adjacent pipe to 95 percent of its vertical diameter.

d. Workmanship

1. Line and Grade

(a) Survey control hubs for both line and grade shall be provided by the design engineer in a manner consistent with accepted practices. The contractor shall establish line and grade for pipe by the use of lasers or by transferring the cut from the offset

stakes to the trench at a maximum of 50-foot intervals, to maintain the line and grade.

(b) Variance from the established line and grade shall not be greater than ¼ inch for grade and ½ inch for line, provided that such variation does not result in a level or reverse-sloping invert.

(c) The contractor shall check line and grade as necessary. If the limits prescribed in these standards are not met, the work shall be immediately stopped, the Public Works Department authorized representative notified, and the cause remedied before proceeding with the work.

(d) Variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, shall not exceed 1/64 per inch of pipe diameter, or ½ inch maximum.

(e) Tee stations shall be staked as specified in Subsection 4.1.5, "Surveying," to enable the contractor to install services at the correct property location.

2. Pipe Handling

(a) The contractor shall unload pipe only by approved means. Pipe shall not be unloaded by dropping it to the ground and shall not be dropped or dumped into trenches.

(b) The contractor shall inspect all pipe and fittings before lowering them into trenches to ensure that no cracked, broken, or otherwise defective materials are used.

(c) The contractor shall clean the ends of pipe thoroughly, remove foreign matter and dirt from inside the pipe, and keep it clean during laying and joining.

(d) The contractor shall lower the pipe into the trench in such a manner as to avoid any physical damage to the pipe.

(e) The contractor shall remove all damaged pipe from the job site.

3. Tying In

(a) The contractor shall not break into an existing sewer line until just before the project is finalized and the manhole has been tested and approved by the Public Works Department authorized representative.

(b) When a contractor ties into a "live" line, the contractor shall keep the new line plugged at the downstream end of the construction to prevent groundwater from entering the City's sewage system.

4. Foreign Material

(a) The contractor shall take all necessary precautions to prevent excavated or other foreign material from entering the pipe during the laying operation.

(b) At all times, when laying operations are not in progress, the contractor shall use a mechanical plug at the open end of the last laid section of pipe, to prevent entry of foreign material or creep of the gasketed joints.

5. Pipe Laying

(a) Pipe laying shall proceed upgrade, with the spigot ends pointing in the direction of flow.

(b) After a section of pipe is lowered into the prepared trench, the contractor shall clean the end of the pipe to be joined, the inside of the joint, and the rubber ring (if required) immediately before joining the pipe.

(c) At the location of each joint, dig bell (joint) holes of ample dimensions in the bottom of the trench and at the sides, where necessary, to permit the joint to be made properly.

(d) The joint shall be assembled according to the recommendations of the manufacturer. The contractor shall provide all special tools and appliances required

for the jointing assembly. After the joint is made, the pipe shall be checked for alignment and grade.

(e) The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between joints.

(f) Do not lay pipe in water or when, in the opinion of the Public Works Department authorized representative, trench conditions are unsuitable.

6. Movable Shield: When pipe is laid in a movable trench shield, the contractor shall take all necessary precautions to prevent the pipe joints from pulling apart when the shield is moved ahead. The bottom of the shield shall not extend below the spring line of the pipe without recompacting the pipe zone.
7. Cutting Pipe: When cutting or machining the pipe is necessary, the contractor shall use only the tools and methods recommended by the pipe manufacturer and approved by the Public Works Department authorized representative. The contractor shall cut ductile iron pipe using a method approved by the Public Works Department authorized representative; all burrs or rough edges shall be removed before joining pipe. The contractor shall not flame-cut the pipe.
8. Transition Fittings: When joining different types of pipes, the contractor shall use approved ridged fittings. Flexible fittings such as Fernco, Caulder, or approved equal may be considered upon approval of the Public Works Department authorized representative; flexible fittings may require additional support under the coupling. Bell type couplings are considered flexible.
    1. Shear ring/ridge transition couplings meeting the ASTM C-564 or equal shall be used.
    2. PVC couplers or adapters shall meet the specifications for ASTM D-3034, SDR 35 pipe fittings.
    3. Ductile iron transition couplings shall be manufactured from ductile iron conforming to ASTM A-536, grade 65-45-12, for center and end rings. Rubber gaskets, bolts, and nuts shall conform to AWWA C-111/ANSI A21.11.
9. Concrete Closure Collars
    (a) The contractor shall pour closure collars against undisturbed earth, remove all water from the excavation, and construct suitable forms to create shapes that will provide full bearing surfaces against undisturbed earth.

    (b) Closure collars shall be used only when approved by the Public Works Department authorized representative, and then only to make connections between dissimilar pipe or where standard rubber-gasketed joints are impractical.

    (c) Before the closure collars are installed, the contractor shall wash the pipe to remove all loose material and soil from the surface where they will be placed.
10. Pipe Zone Material: The contractor shall install pipe zone material uniformly on both sides of the pipe, up to the spring line of the pipe. Material shall be placed in lifts not exceeding 6 inches Material shall be well worked with hand tools to ensure proper support in the haunching area.
11. Line Taps
    (a) Line taps shall be core drilled unless approved otherwise by the Public Works Department authorized representative. Core drilled holes shall be done using a cylinder-style hole saw for only plastic pipe material or a diamond core bit for concrete and D.I. pipes.

    (b) Line tap connections to existing sanitary lines may be done using either saddle tees or by using Inserta Tee® saddle tees or by using Inserta Tee® as per Subsection 3.10.3, “Stormwater Pipe and Fittings”.

(c) Line taps shall be centered on the spring line of the pipe being tapped.
(d) The area around the saddle installation site shall be cleaned and free of all rough edges before installing the saddle.
(e) While installing the saddle, no rock, dirt, or debris shall be allowed to enter the main sewer line from the core hole.
(f) The contractor shall install ¾"-0" crushed aggregate in the pipe zone around the line tap, from 6 inches below the pipe to 12 inches above the pipe.
(g) Laterals shall have tracer wire (12-gauge with green THNN insulation) installed beside the pipe.

4.4.3 Pressure Mains

a. General Provisions
These specifications, together with all other applicable requirements of federal, state, and local law, shall govern the character and quality of material, equipment, installation, and construction procedures for pressurized sanitary sewer work.

b. Materials
1. Ductile Iron Pipe: Ductile iron pipe shall be lined with cement mortar and seal-coated and shall conform to applicable portions of the following specifications: ASTM A-536, AWWA C-104/ANSI A21.4, AWWA C-111/ANSI A21.11, and AWWA C-151/ANSI A21.51.
2. PVC Pipe: PVC pipe with diameters of 4 inches through 12 inches shall conform to the requirements of AWWA C-900. Joints shall be elastomeric gasketed and shall conform to the requirements of ASTM D-3139.
3. High Density Polyethylene Pipe (HDPE): HDPE pipe with diameters of 4 inches through 63 inches shall conform to the requirements of AWWA C-906. Joints shall be joined by thermal heat fusion and shall conform to the requirements of ASTM D-2683 for socket-type fittings, ASTM D-3261 for butt-type fittings, or ASTM F-1055 for electrofusion-type fittings.

c. Workmanship and Pipe Installation
1. All pipe shall be laid to the specified lines and grades. The minimum depth of the pipe cover shall be as specified in Subsection 4.2.2, "Sanitary Pipe Design." Pipes shall not be deflected either horizontally or vertically beyond the limits established and recommended by the pipe manufacturer.
2. Pipeline shall be laid to a grade that results in the minimum number of high points, based on terrain and economic considerations. Abrupt transitions and sharp peaks shall be avoided.
3. All tees, elbows, or other fittings shall be produced by the pipe manufacturer and shall be properly braced, anchored, or blocked.
4. Automatic air and vacuum release valves with a bleed-off port shall be installed at all high points or locations in the pipeline where air pockets would be expected to accumulate. Valves shall be installed in a vault so as to provide accessibility for service and repair. Sumps shall be required for holding excess liquid discharged from the bleed-off port.

4.5 CONSTRUCTION SPECIFICATIONS

4.5.1 General Provision

The specifications detailed here, together with the standards established by the Oregon DEQ, the U.S. Environmental Protection Agency, and any other applicable requirements of the City, shall govern the character and quality of material, equipment, installation, and construction procedures for mainline sanitary sewer work of gravity-flow systems.

4.5.2 Scheduling

The contractor shall plan their construction work in conformance with Subsection 1.17.2, "Scheduling."

4.5.3 Environmental Protection, Erosion Prevention, and Sediment Control

The contractor shall take all appropriate measures and precautions to minimize the work's impact on the environment and shall control erosion, as outlined in Subsection 1.18, "Environmental Protection, Erosion Prevention, and Sediment Control."

4.5.4 Interferences and Obstructions

Various obstructions may be encountered during the course of the work. The contractor shall follow the guidelines established in Subsection 1.17.5, "Interferences, Obstructions, and Abandoned Utilities."

4.5.5 Contaminated Soil or Hazardous Material

If during construction contaminated soil or with hazardous materials or chemicals are encountered, the Contractor shall follow the procedures specified in Subsection 1.18.2, "Contaminated Soils or Hazardous Materials."

4.5.6 Trench Excavation, Preparation, and Backfill

Trench excavation, preparation, and backfill shall conform to the requirements of Section 6, "Trench Excavation and Backfill Standards."

4.5.7 Preservation, Restoration, and Cleanup

Cleanup of all construction debris, excess excavation, and excess materials and complete restoration of all fences, mailboxes, ditches, culverts, signposts, and similar items shall be completed according to Subsection 1.17.16, "Preservation, Restoration, and Cleanup."

4.5.8 Bores

Bores shall conform to the requirements of Subsection 3.11.8, "Bores."

4.6 TESTING PROCEDURES

4.6.1 General

a. Testing Order: Sanitary systems and appurtenances shall pass a deflection test and an air test before acceptance and shall be free of visible leakage. Information about air testing may be obtained from the Public Works Department authorized representative. Individual joints on pipe 54 inches in diameter or larger may be tested by an approved joint-testing device. All details of testing procedure shall be subject to approval of the Public Works Department authorized representative. Testing of sanitary systems shall be conducted in the following order.
    1. Deflection testing of pipelines.
    2. Air pressure testing of pipelines.
    3. Video-inspection of pipelines.
    4. Vacuum testing of manholes
b. If repair work is required on a section of the system, that portion of the system shall be retested in the testing order given above.
c. Deflection testing, air pressure testing, and video-inspection shall be done only after backfill has passed the required compaction test(s) based on AASHTO T-180 and roadway base rock has been placed, compacted, and approved.

d. The sanitary system must pass deflection testing, air pressure testing, and video-inspection before paving of overlying roadways will be permitted.
e. Vacuum testing of manholes shall be performed only after paving is completed and approved.

4.6.2 Line Cleaning

Before testing and City inspection of the system, the contractor shall ball and flush and clean all parts of the system. The contractor shall remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the system at or near the closest downstream manhole. If necessary, the contractor shall use mechanical rodding, bucketing or vactor equipment. When the City's authorized representative inspects the system, any foreign matter still present shall be flushed and removed from the system. Contractor shall provide screening; no material shall be flushed into the downstream city sewer system.

4.6.3 Deflection Testing for Flexible Pipe

Storm systems constructed of flexible pipe shall be deflection-tested by pulling an approved mandrel through the completed pipeline. The diameter of the mandrel shall be 95% of the nominal pipe diameter, unless otherwise specified by the City's authorized representative. The mandrel shall be a rigid, nonadjustable, odd-numbered-leg (9 legs minimum) mandrel having an effective length of not less than its nominal diameter. Testing shall be done manhole-to-manhole and after the line is completely balled and flushed with water, and after compaction tests of backfill are completed and accepted. The contractor shall be required to locate and repair any sections that fail the test and to retest those sections. All repairs shall follow and be in compliance with the manufacturer's recommendations.

4.6.4 Video Inspection of Gravity Systems

All storm systems shall be video-inspected and approved prior to City acceptance. Video inspection shall take place after trench backfill and compaction has been completed and accepted, and channels have been poured in manholes. All pipes shall be thoroughly flushed immediately prior to the video inspection; only that water remaining from flushing shall be present in the system. The camera shall have the ability to tilt up to 90 degrees and rotate 360 degrees on the axis of travel. An inspection of all lateral connections shall be conducted using the tilt capabilities of the camera. A 1.0-inch target ball shall be placed in front of the camera. Observed sags must be less than 0.5 inch.
The City's authorized representative shall be notified and shall be present during video-inspection of the system, unless otherwise approved by the City's authorized representative. A copy of the video and a written video inspection report, on a City-approved form, shall be supplied to the City's authorized representative. The video shall be recorded in color and in DVD or CD format. Video shall include a visual footage meter recording. Problems revealed during the inspection shall be noted on the video and in the written report. After repairs have been made, the line shall be re-inspected and re-tested. If excessive foreign material, in the opinion of the City's authorized representative, is encountered during video inspection, the line shall be balled and flushed, and re-video inspected.

4.6.5 Air Pressure Testing

a. General: After the system is complete, including service connections and backfilling, the contractor shall conduct a low-pressure air test. The contractor shall provide all equipment and personnel for the test. The method, equipment, and personnel shall be subject to

approval of the Public Works Department authorized representative. The Public Works Department authorized representative may, at any time, require a calibration check of the instrument used. The pressure gauge shall have minimum divisions of 0.10 psi and an accuracy of 0.0625 psi (one ounce per square inch). All air shall pass through one control panel.

b. Safety Precautions: All plugs used to close the sewer for the air test must be capable of resisting the internal pressures and must be securely braced. All air-testing equipment must be placed above ground. No one shall be permitted to enter a manhole or trench where a plugged line is under pressure. All pressure must be released before the plugs are removed. The testing equipment must include a pressure-relief device designed to relieve pressure in the line under test at 10 psi or less and must allow continuous monitoring to avoid excessive test pressure. The contractor shall use care to prevent the air inlet from flooding with infiltrated groundwater. The contractor shall inject air at the upper plug if possible. Only qualified personnel shall be permitted to conduct the test.

c. Method: Air testing shall be by the time pressure drop method, as follows:
   1. Clean the lines to be tested and remove all debris.
   2. Wet the lines before testing (optional).
   3. Plug all open ends with suitable test plugs; brace each plug securely.
   4. Check the average height of groundwater over the line. Add air slowly to the section of the system being tested until the internal air pressure is 3.5 psi higher than the average pressure of groundwater (0.433 psi for each foot of average water depth over the line).
   5. After the internal test pressure is reached, allow at least two minutes for the air temperature to stabilize, adding only the amount of air required to maintain pressure.
   6. After the temperature stabilization period, disconnect the air supply.
   7. Determine and record the time (in seconds) required for the internal air pressure to drop from 3.5 psi to 2.5 psi.
   8. Compare the time recorded in step (g) above with the time required, as determined below.

d. Passing test: A passing test shall be based on meeting or exceeding the requirements below. The test method depends on the type of pipe material. If a line fails to meet the requirements, the contractor shall repair or replace all defective materials or workmanship.
   1. Concrete pipe
      Air pressure drop method: The tested section, when tested by the air pressure drop method, will be acceptable if the time required for the pressure to drop from 3.5 psi to 2.5 psi is not less than the time (T) in seconds (**Table 4.5**) computed by the following formula:

      $T = K/C$

      Where: $K = 0.011 \times d^2L$.

      $C = 1$ or $0.0003882 \times dL$, whichever is greater.

      $d =$ inside diameter of pipe (inches).

      $L =$ length of pipe (feet).
   2. PVC, HDPE, and ductile iron pipe
      The minimum duration for the prescribed low-pressure exfiltration pressure drop between two consecutive manholes shall not be less than that shown in **Tables 4.6** or **4.7**. The table lists test duration values for pressure drops of 1.0 psi and 0.5 psi in excess of groundwater pressure above the top of the sewer pipe. Values accommodate both an allowable average loss per unit of surface area and an allowable maximum total leakage rate.

3. Record the diameter (inches), length (feet), end manhole number, time, pressure drop, and groundwater level of the test on an inspection form. The form shall become part of the permanent record for the project.

Table 4.5. AIR TESTING OF CONCRETE PIPE

Pipe Diameter (inches)											
	4	6	8	10	12	15	18	21	24	30	36
Pipe Length (ft.)	Time (sec)	Time (sec)	Time (sec)	Time (sec)	Time (sec)	Time (sec)	Time (sec)	Time (sec)	Time (sec)	Time (sec)	Time (sec)
10	1.8	4.0	7.0	11.0	15.8	24.8	35.6	48.5	63.4	99.0	142.6
20	3.5	7.9	14.1	22.0	31.7	49.5	71.3	97.0	126.7	198.0	285.1
30	5.3	11.9	21.1	33.0	47.5	74.3	106.9	145.5	190.1	297.0	427.7
40	7.0	15.8	28.2	44.0	63.4	99.0	142.6	194.0	253.4	396.0	570.2
50	8.8	19.8	35.2	55.0	79.2	123.8	178.2	242.6	316.8	495.0	712.8
60	10.6	23.8	42.2	66.0	95.0	148.5	213.8	291.1	380.2	594.0	855.4
70	12.3	27.7	49.3	77.0	110.9	173.3	249.5	339.6	443.5	693.0	997.9
80	14.1	31.7	56.3	88.0	126.7	198.0	285.1	388.1	506.9	792.0	**1020.1**
90	15.8	35.6	63.4	99.0	142.6	222.8	320.8	436.6	570.2	**850.1**	*Same after 72 ft.*
100	17.6	39.6	70.4	110.0	158.4	247.5	356.4	485.1	633.6	*Same after 86 ft.*	
110	19.4	43.6	77.4	121.0	174.2	272.3	392.0	533.6	**680.1**		
120	21.1	47.5	84.5	132.0	190.1	297.0	427.7	582.1	*Same after 108 ft.*		
130	22.9	51.5	91.5	143.0	205.9	321.8	463.3	**595.1**			
140	24.6	55.4	98.6	154.0	221.8	346.5	499.0	*Same after 123 ft.*			
150	26.4	59.4	105.6	165.0	237.6	371.3	**510.0**				
160	28.2	63.4	112.6	176.0	253.4	396.0	*Same after 144 ft.*				
170	29.9	67.3	119.7	187.0	269.3	420.8					
180	31.7	71.3	126.7	198.0	285.1	**425.0**					
190	33.4	75.2	133.8	209.0	301.0	*Same after 172 ft.*					
200	35.2	79.2	140.8	220.0	316.8						
210	37.0	83.2	147.8	231.0	332.6						
220	38.7	87.1	154.9	242.0	**340.0**						
230	40.5	91.1	161.9	253.0	*Same after 215 ft.*						
240	42.2	85.0	169.0	264.0							
250	44.0	99.0	176.0	275.0							
260	45.8	103.0	183.0	**283.4**							
270	47.5	106.9	190.1	*Same after 258 ft.*							
280	49.3	110.9	197.1								
290	51.0	114.8	204.2								
300	52.8	118.8	211.2								
310	54.6	122.8	218.2								
320	56.3	126.7	225.3								
330	58.1	130.7	**226.7**								
340	59.8	134.6	*Same after 322 ft.*								
350	61.6	138.6									
360	63.4	142.6									
370	65.1	146.5									
380	66.9	150.5									
390	68.6	154.4									
400	70.4	158.4									
410	72.2	162.4									
420	73.9	166.3									
430	75.7	**170.0**									
440	77.4	*Same after 430 ft.*									
450	79.2										
460	81.0										
470	82.7										
480	84.5										
490	86.2										
500	88.0										

Table 4.6. AIR TESTING OF PVC, HDPE, AND DUCTILE IRON PIPE – 1.0 PSIG PRESSURE DROP[1]

Pipe Diameter	Minimum Time	Length for Minimum Time	Time for Longer Length	Specified Minimum for Length (L) Shown (min:sec)							
(inches)	(min:sec)	(feet)	(sec)	100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
4	3:46	597	0.380L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.647L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46
42	39:48	57	41.883L	69:48	104:42	139:37	174:30	209:24	244:19	279:13	314:07
48	45:34	50	54.705L	91:10	136:45	182:21	227:55	273:31	319:06	364:42	410:17

Specification Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe indicated for Q=0.0015, where Q is the allowable leakage rate in $ft^3/min/ft^2$ of inside surface area of pipe.

1. Data from the UNI-Bell® PVC Pipe Association

Table 4.7. AIR TESTING OF PVC, HDPE, AND DUCTILE IRON PIPE – 0.5 PSIG PRESSURE DROP[1]

Pipe Diameter	Minimum Time	Length for Minimum Time	Time for Longer Length	Specified Minimum for Length (L) Shown (min:sec)							
(inches)	(min:sec)	(feet)	(sec)	100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
4	1:53	597	0.190L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:24	99	6.837L	11:24	17:57	22:48	28:30	34:11	39:24	45:35	51:17
27	14:25	88	8.653L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	17:48	80	10.683L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	21:33	72	12.926L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	25:39	66	15.384L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23
42	34:54	57	20.942L	34:54	52:21	69:49	87:15	104:42	122:10	139:37	157:04
48	45:35	50	27.352L	45:35	68:23	91:11	113:58	136:46	159:33	182:21	205:09

Specification Time Required for a 0.5 psig Pressure Drop for Size and Length of Pipe indicated for Q=0.0015, where Q is the allowable leakage rate in $ft^3/min/ft^2$ of inside surface area of pipe.

1. Data from the UNI-Bell® PVC Pipe Association

4.6.6 Manhole Testing

Sanitary sewer manholes shall be tested for acceptance after the trench is backfilled, compaction requirements are met, the road base rock is installed, and the street paved, and chimney seals or concrete manhole closure collars are installed. If the manholes pass the tests but the castings were disturbed by construction and must be reinstalled, the manholes shall be retested.

a. Vacuum Testing: All manholes being constructed or rehabilitated shall be vacuum-tested. The test shall consist of plugging all inlets and outlets. The test head shall be placed at the inside of the top of the cone and shall include grade rings and casting. The seal shall be inflated in accordance with the manufacturer's recommendations. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if the time for the vacuum reading to drop to 9 inches meets or exceed the values listed in **Table 4-8**. The contractor shall repair all manholes that fail to pass the vacuum test; manholes shall be retested to verify the repair.

Table 4.8. VACUUM TESTING OF MANHOLES

Depth of Manhole (feet)	Diameter of Manhole		
	48 Inch	60 Inch	72 Inch
	Allowable Time (seconds)		
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	65
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

b. Hydrostatic Testing: When, in the opinion of the Public Works Department authorized representative, the groundwater table is too low to visually detect leaks, manholes may be hydrostatically tested. The test shall consist of plugging all inlets and outlets, then filling the manhole with water to a height determined by the Public Works Department authorized representative. Leakage in each manhole shall not exceed 0.2 gallons per hour per foot of head above the invert. Leakage will be determined by refilling to the rim using a calibrated or known volume container. A manhole may be filled 24 hours before the test, if desired, to

permit normal absorption into the pipe walls to take place. The contractor shall repair all manholes that fail to pass the leakage test; manholes shall be retested to verify the repair.

4.6.7 Pressure Main Testing

Field testing of the force main and appurtenances shall be completed by a hydrostatic test that meets the following requirements. Contractor shall be responsible for making all necessary provisions for conveying water to the points of use and for disposal of the test water, including temporary taps and plugs.

a. Prior to the start of the hydrostatic test, all trenching shall be backfilled, compacted, and accepted per the requirements of Section 6, "Trench Excavation and Backfill Standards."
b. When concrete thrust blocks are used, the hydrostatic test shall be conducted after at least five days elapse from when the concrete thrust blocking was installed. If high-early cement is used for the concrete thrust blocking, the time may be cut by two days.
c. Seal pipe ends and secure pipe with temporary thrust restraint, as required, to maintain line and grade and to prevent damage.
d. Fill the test section with water and allow it to stand at two-thirds of the test pressure for a minimum of 12 hours. All air shall be purged from the pipeline before it is checked for leaks or pressure or acceptance tests are performed on the system.
e. Furnish all equipment and materials and perform testing in conformance with Subsection 5.9.1, "Hydrostatic Testing."
f. If a large amount of water is required to increase the pressure during testing, entrapped air, leakage at joints, or a broken pipe can be suspected. In such cases, tests shall be discontinued until the source of trouble is identified and corrected.
g. Visible leaks in the wet well and vaults shall be eliminated regardless of the leakage amount.

4.7 WARRANTIES AND ACCEPTANCE

4.7.1 Legal Recordings

Dedication of any required easements or rights-of-way have been recorded with the County Recorder and the Engineering Department receives a reproducible copy of the recorded documents.

4.7.2 Project Completion

After completion of construction of the total project, and after all testing has been satisfactorily completed, project closeout shall proceed as outlined in Subsection 1.17.17, "Project Closeout."

4.7.3 Maintenance Period

a. The Contractor or Applicant shall be responsible for providing Maintenance Assurance for Public Improvements as outlined in Subsection 1.17.18, "Maintenance Assurance and Warranty." Public sanitary improvements shall be warranted for a minimum of one year; public landscape improvements shall be warranted for a minimum of two years.
b. At any time during the warranty period, the Public Works Department authorized representative has reason to believe the public sanitary improvements have defects that were the result of faulty workmanship or flaws in construction material, the responsible party shall be required, at that party's own cost, to video-inspect the sewer line and repair any problems or faults revealed during video inspection by replacing those sections. The video inspection shall be done during the winter, if possible, or during the wet weather months, to identify all leaks.

c. Before the end of the Construction Maintenance period, the City's authorized representative shall inspect the project for any remaining deficiencies. If the deficiencies that remain are determined to be the responsibility of the contractor or the applicant, the contractor or applicant shall then make such repairs.
d. The Landscape Maintenance assurance shall be released two years after acceptance of construction, providing the landscaping meets the 90% survival level (see Subsection 3.13.2, “Landscape Inspection for Warranty”).

SECTION 5 – WATER DESIGN & CONSTRUCTION STANDARDS

5.1 ENGINEERING

5.1.1 Introduction

This section outlines design and construction requirements for all public water system improvements. These provisions and technical specifications set forth the requirements of the City of Molalla for constructing water system improvements. Interpretations of such provisions and their application in specific circumstances shall be made by the Public Works Department authorized representative. Refer to Section 1 of the "Public Works Standards" for general provisions and requirements.

5.1.2 Extension of Public Water Systems

Except as otherwise provided, the extension or upsizing of the public water systems to serve any parcel or tract of land shall be done by, and at the expense of, the property owner or permit applicant. New water systems shall extend to the far side of the property to allow for future extensions beyond present development and be consistent with the Water Master Plan.

5.1.3 Water Plans

a. It is the design engineer's responsibility to ensure that engineering plans are sufficiently clear and concise to construct the project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill the intent of these design standards.
b. All elevations on design plans and record drawings shall be based on the applicable NAVD 88 Datum specified in Section 1.16.6, "Surveying and Land Monuments".
c. Existing conditions and facilities on design plans and record drawings shall be shown in light, gray print. Proposed conditions and facilities on design plans and record drawings shall be shown in bold, black print.
d. All engineering water plans shall be stamped by a Professional Engineer registered in the State of Oregon. At a minimum, water plans shall contain the following:
    1. At least one sheet shall show a plan view of the entire project site. If the project site is sufficiently large that detailed water plans on any given sheet do not encompass the entire project site, then a sheet showing the plan view of the entire site must serve as an index to subsequent detailed plan sheets.
    2. A topographic map showing existing conditions for the site, including the following:
        a) Existing topography for the site. Plan views showing existing features may be required for a distance of up to 100 feet (or further if warranted) beyond the proposed improvement in order to prevent future grade conflicts and will be determined on a case-by-case basis by the City's authorized representative.
        b) Adjacent streets, trails, multi-use paths, and rail lines, including the respective names.
        c) Existing utilities, including franchised utilities above or below ground and drainage facilities that transport surface water onto, across, or from the project site. Existing drainage pipes, culverts, and channels shall include the invert or flow line elevations.
        d) Existing vegetation, including denoting the type, DBH, and canopy size of trees within the construction limits.
        e) Existing environmentally sensitive areas (e.g., ravines, swales, steep slopes, wells, springs, wetlands, creeks, lakes, etc.). For natural drainage features, show direction of flow, drainage hazard areas, and 100-year floodplain boundary (if applicable).

f) Adjacent existing features that are within 25 feet outside of the site boundary, including but not limited to construction activities that will potentially compromise the structural stability or condition of off-site features, such as cultivated vegetation, landscaping and trees, buildings, fences, decks, walls, slabs, and pavements. Denote the type, DBH, and canopy size of all trees.

3. Plans for proposed water improvements shall include the following:
   a) Grading and erosion control plan.
   b) Finished grades, showing the extent of cut and fill by existing and proposed contours, profiles, or other designations. Plan views showing existing features may be required for a distance of up to 100 feet (or further if warranted) beyond the proposed improvement in order to prevent future grade conflicts and will be determined on a case-by-case basis by the City's authorized representative.
   c) Horizontal stationing along centerline, showing points of tangency and curvature, including centerline stationing of all intersecting streets.
   d) Proposed structures, including roads and road improvements, parking surfaces, building footprints, walkways, landscape areas, etc.
   e) Water facilities, including pipe sizes, pipe types and materials, lengths, joint restraints, and all water system appurtenances, including, but not limited to valves, hydrants, fittings, vaults, meters and thrust blocks. Notes shall be included for referencing details, cross-sections, profiles, etc.
   f) Existing and proposed utilities, showing exact line and grade of all utilities crossing the proposed water system.
   g) Connection details at all locations of water system appurtenances, including the size, type, spacing, and connection style of valves, bends, tees, crosses, reducers, thrust blocks and other water system appurtenances as required by the City's authorized representative.
   h) Applicable detail drawings.
   i) Existing and proposed property lines, right-of-way lines, survey monuments, and easements.
   j) Setbacks from environmentally sensitive areas or resource areas protected within the wetland sensitive areas.
   k) Any proposed phasing of construction.
   l) Any additional information that the City's authorized representative deems necessary.
4. Profiles for proposed water improvements will be provided at the same horizontal scale as the plan sheets and a 1" = 5' vertical scale. Profile drawings shall be drawn below the plan view or immediately following the associated plan view sheets. Profile views showing existing features may be required for a distance of up to 100 feet (or further if warranted) beyond the proposed improvement in order to prevent future grade conflicts and will be determined on a case-by-case basis by the City's authorized representative. The profiles shall include the following:
   a) Existing and proposed ground along the proposed water main alignment.
   b) Water facilities, including pipe sizes, pipe types and materials, lengths, backfill material, joint restraints, and all water system appurtenances, including, but not limited to valves, hydrants, fittings, vaults, meters and thrust blocks. Notes shall be included for referencing details, cross-sections, etc.
   c) Existing and proposed utilities, showing exact line and grade of all utilities crossing the proposed water system. The vertical separation from existing and proposed utilities shall be labeled for all proposed utility crossings.

d) Any additional information that the City's authorized representative deems necessary.

5.1.4 Surveying

a. The design engineer shall be responsible for establishing the location of the water line by means of reference stakes offset along the centerline of the water line. No construction shall be allowed to begin before construction staking. All staking shall be performed by or under the direction of a Professional Land Surveyor registered in the State of Oregon.
b. Stakes shall locate all public tees, crosses, bends, fire hydrants, blow offs, isolation valves, vaults, and booster pump stations. Maximum spacing for reference stakes is 50 feet. Stakes shall reference cuts and fills to the finished grade of the ground, asphalt, or concrete surface at that location to maintain minimum cover requirement. The design engineer shall also be responsible for identifying and staking easements during construction.

5.2 DESIGN GUIDELINES

5.2.1 Fire Protection and Flow Requirements

a. Water system design shall provide adequate flow for fire protection and maximum water usage and consumption. Required water demands shall be met by maintaining the minimum operation pressures required by the City. For single family residential areas, the minimum static pressure shall be 40 PSI and the minimum fire flow shall be 1500 GPM at 20 PSI. For all other developments, the required fire flow shall be as determined by the Fire District.
b. Velocity in distribution mains shall be designed not to exceed five feet per second. Velocity in service lines shall not exceed ten feet per second.

5.2.2 Pipe Cover

a. The standard minimum cover over buried water mains with the street right-of-way or easements shall be thirty (30) inches from finished grade to top of pipe.
b. Where waterlines are constructed on slopes greater than 20%, in areas designated as hazardous, or where there are site conditions that may cause damage to improvements due to slippage or slides as determined by the Public Works Director, a soils and/or geologic report may be required. Where the finished graded surface is greater than 20%, or as required by the Public Works Director, soil stabilization fabric shall be placed over the entire disturbed area.

5.2.3 Separation with Sewer Systems

a. Water mains shall be installed a minimum clear distance of ten feet horizontally from all sanitary sewer mains and shall be installed to go over the top of such sewers with a minimum of eighteen inches of clearance at intersections of these pipes. Exceptions shall first be approved by the Public Works Director. In all instances, the distances shall be measured edge to edge. The minimum spacing between water mains and storm drains, gas lines, and other underground utilities, excepting sanitary sewers, shall be three feet (3') horizontally when the standard utility location cannot be maintained. Where waterline designs parallel other waterlines, utility pipe, or conduit lines, the vertical separation shall be twelve inches below or in such a manner which will permit future side connections of mains, hydrants, or services and avoid conflicts with parallel utilities without abrupt changes in vertical grade of the above mentioned main, hydrant, or service. Where crossing of utilities are required, the minimum vertical clearance shall be six inches.

5.2.4 Alignment

a. All waterlines shall be located within public right-of-way or as directed by the Public Works Director. These lines are placed in the public right-of-way for ease of maintenance and access, control of the facility, operation of the facility, and to permit required replacement and/or repair. The Public Works Director, under special conditions, may allow a public waterline to be located within a public water easement if no other options are available.
b. Water systems shall be located twelve feet south and east from the right-of-way centerline or as directed by the Public Works Director. All abrupt changes in vertical or horizontal alignment shall be made with a concrete thrust block and MegaLug fitting as required by the Public Works Director. Curved alignment for water lines or main is permitted and shall follow the street centerline when practical. The minimum allowed radius shall be based on allowable pipe deflection for the pipe diameter and the pipe laying length but not to exceed 3° joint deflection.
c. Dead-end mains which will be extended in the future shall be provided with a line-size gate valve, tie rodded MJ plug at the end. The valve plug shall be tapped with a 2” standard blow-off, except that the 2" gate valve shall not be installed. Permanent dead-end mains shall terminate with a standard blow-off assembly.

5.2.5 Relation to Watercourses

a. Above Water Crossings:
    1. The pipe shall be engineered to provide support, anchorage, and protection from freezing and damage, yet shall remain accessible for repair and maintenance.
    2. All above water crossings will require review and approval by the Public Works Director.
    3. Valves shall be provided at each end so that the section can be isolated for testing or repair. Valves shall be accessible and not subject to flooding.
    4. The valve nearest to the supply source shall be in a manhole. Permanent taps shall be made on each side of the valve within the manhole to allow insertion of a small meter for testing to determine leakage and for sampling.
    5. Provide air/vacuum relief valves in locations where air can become trapped.
b. Under Water Crossings:
    1. Mains crossing streams or drainage channels shall be designed to cross as nearly perpendicular to the channel as possible.
    2. The minimum cover from the bottom of the stream bed or drainage channel to the top of pipe shall be 36 inches.
    3. A scour pad centered on the waterline will be required when the top of pipe to bottom of the stream bed or drainage channel is 30 inches or less. The scour pad shall be concrete, 6 inches thick, 6 feet wide, and reinforced with #4 rebar placed 12 inches on center each way. The scour pad shall extend horizontally to a point behind the top of bank equal to the height of cover over the pipe at the top of bank.
    4. Valves shall be provided at each end so that the section can be isolated for testing or repair. Valves shall be accessible and not subject to flooding.
    5. The valve nearest to the supply source shall be in a manhole. Permanent taps shall be made on each side of the valve within the manhole to allow insertion of a small meter for testing to determine leakage and for sampling.
    6. Provide air/vacuum relief valves in locations where air can become trapped.
c. Case-by-case Pipe Crossings
    1. Stream or channel crossings for pipes 12 inches and larger.
    2. River or creek crossings requiring special approval from the Division of State Lands.

5.2.6 Valves

Valves shall be the same size as the mains in which they are installed. Valves shall be installed on each leg of tees and crosses.

5.3 OPERATION OF VALVES IN CITY

Contractor shall request City operation of valves at least 24 hours in advance. At no time shall the contractor undertake to close off or open valves or take any other action that would affect the operation of the existing water system.

5.4 MATERIAL AND TECHNICAL SPECIFICATIONS

All public water distribution systems shall be constructed with C900/C905 PVC or cement mortar lined ductile iron pipe.

5.4.1 Joints

Pipe joints shall be push-on joints, except where specifically shown or detailed otherwise. Fitting joints shall be mechanical joint ends, except where specifically shown or detailed otherwise. All valves joined to tees and crosses shall be flanged by mechanical joint.

5.4.2 Mechanical Joint Fittings

Mechanical joint D.I. fittings shall conform to the latest revision of AWWA C-110/ ANSI A21.10 and shall be of a class at least equal to that of the adjacent pipe. Bolts and nuts shall conform to AWWA C-111/ANSI A21.11. Mortar lining for fittings shall be the same thickness specified for pipe.

5.4.3 Push-On Pipe

a. Ductile Iron: Pipe shall be cement mortar lined and shall conform to AWWA C-104/ANSI A21.4, AWWA C-111/ANSI A21.11, and AWWA C-151/ANSI A21.51 as manufactured by U.S. Pipe and Foundry Company, Pacific States Cast Iron Company, American Ductile Iron Pipe, or approved equal. All water mains 12" or less shall be minimum pressure class 350 ductile iron. All water mains 14" and greater shall be minimum pressure class 300 ductile iron. Rubber ring gaskets shall conform to Subsection 5.4.5, "Push-on Gaskets," and shall be furnished with the pipe. A nontoxic vegetable soap lubricant (meeting the requirements of AWWA C-111/ ANSI A21.11) shall be supplied with the pipe in sufficient quantities for installing the pipe furnished.
b. C900/C905 PVC: Pipe shall conform to ANSI/AWWA C900, ANSI/AWWA C905 as manufactured by JM Eagle, PW Eagle, or approved equal. All PVC water mains shall be minimum pressure rated at 235 psi (DR 18). Rubber ring gaskets shall conform to Subsection 5.4.5, "Push-on Gaskets," and shall be furnished with the pipe. A nontoxic vegetable soap lubricant (meeting the requirements of AWWA C-111/ ANSI A21.11) shall be supplied with the pipe in sufficient quantities for installing the pipe furnished.

5.4.4 Flanged Ductile Iron Fittings

Flanged fittings shall conform to ANSI/AWWA C-207 Class D or ANSI B16.5 150-lb class for pressure ratings up to 150 psi, and either ANSI/AWWA C-207 Class E or ANSI B 16.5 150-lb class for pressure ratings between 150 psi and 275 psi. Flanges shall have flat faces and attached with bolt holes straddling the vertical axis of the pipe. Bolts and nuts shall conform to AWWA C-111/ANSI A21.11. The fittings shall be cement-mortar lined to same thickness specified for pipe.

5.4.5 Push-on Gaskets

Unless otherwise approved by the Public Works Department authorized representative, locking rubber gaskets shall be used for bell ends when available for the specified pipe size. Locking gaskets shall meet pipe manufacturer's specifications.

5.4.6 Flanged Gaskets

Gaskets shall be suitable for the specified pipe sizes and pressures. Flanged gaskets shall be full-cut, with holes to pass bolts. Gasket material shall be free from corrosive alkali or acid ingredients.

5.4.7 Mechanical Couplings

Mechanical couplings, clamps, or sleeves, not part of the pipe itself, shall be D.I. or steel with rubber rings or gaskets. Gaskets, bolts, and nuts shall conform to AWWA C-111/ANSI A21.11. Couplings, clamps, or sleeves shall be Dresser®, or approved equal.

5.5 CONSTRUCTION SPECIFICATIONS

5.5.1 General Provisions

All installation and testing of water system improvements shall conform to the latest adopted revision of the Oregon Health Division Administrative Rules, Chapter 333, "Public Water Systems," except where the City's provisions exceed those of the state.

5.5.2 Scheduling

The contractor shall plan their construction work in conformance with Subsection 1.17.2, "Scheduling." Newly installed water lines shall not be placed in service until necessary testing and sterilization are complete and system has been approved by the Public Works Department authorized representative.

5.5.3 Environmental Protection, Erosion Prevention, and Sediment Control

The contractor shall take all appropriate measures and precautions to minimize the work's impact on the environment and shall control erosion, as outlined in Subsection 1.18, "Environmental Protection, Erosion Prevention, and Sediment Control."

5.5.4 Interferences and Obstructions

Various obstructions may be encountered during the course of the work. The contractor shall follow the guidelines established in Subsection 1.17.5, "Interferences, Obstructions, and Abandoned Utilities."

5.5.5 Contaminated Soil or Hazardous Material

If during construction contaminated soil or with hazardous materials or chemicals are encountered, the Contractor shall follow the procedures specified in Subsection 1.18.2, "Contaminated Soils or Hazardous Materials."

5.5.6 Trench Excavation, Preparation, and Backfill

Trench excavation, preparation, and backfill shall conform to the requirements of Section 6, "Trench Excavation and Backfill Standards."

5.5.7 Preservation, Restoration, and Cleanup

Cleanup of all construction debris, excess excavation, and excess materials and complete restoration of all fences, mailboxes, ditches, culverts, signposts, and similar items shall be completed according to Subsection 1.17.16, "Preservation, Restoration, and Cleanup."

5.6 PIPE INSTALLATION

5.6.1 Suitable Conditions for Laying Pipe

a. Provide and maintain ample means and devices at all times to remove and dispose of water seepage and runoff entering the trench excavation during the process of pipe laying.
b. Do not lay pipe in water or when, in the opinion of the Public Works Department authorized representative, trench conditions are unsuitable.

5.6.2 Handling

a. Distributing Pipe: Distribute material on the job from vehicles, equipment, or storage yards no faster than it can be used to good advantage. In general, distribute no more than one week's supply of material in advance of the laying.
b. Handling Pipe and Fittings: Provide and use proper implements, tools, and facilities for safe and proper work. Lower all pipe, fittings, and appurtenances into the trench, piece by piece, by means of a crane, sling, or other suitable tool or equipment, to prevent damage to the pipeline materials and protective coatings and linings. Do not drop or dump pipeline materials into the trench.

5.6.3 Cleaning Pipe and Fittings

a. Remove all lumps, blisters, and excess coating from the bell and spigot ends of each pipe. Wire-brush the outside of the spigot and the inside of the bell and wipe them clean, dry, and free from oil and grease before the pipe is laid.
b. Wipe clean all dirt, grease, and foreign matter from the ends of mechanical joint and rubber gasket joint pipe and fittings.

5.6.4 Placing Pipe in Trench

a. Pipe Bells/Joints
    1. At the location of each joint, dig bell (joint) holes of ample dimensions in the bottom of the trench and at the sides, where necessary, to permit the joint to be made properly and to permit easy visual inspection of the entire joint.
    2. Unless otherwise directed, lay pipe with the bell end facing in the direction of the laying.
    3. For lines on steep slopes, face bells upgrade only.
    4. Do not allow foreign material to enter the pipe while it is being placed in the trench.
    5. Lay and join pipe with push-on type joints in strict accordance with the manufacturer's recommendations. Provide all special tools and devices, such as jacks, chokers, and similar items required for the installation. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes shall be permitted under any circumstances.
    6. After the first length of push-on joint pipe is installed in the trench, secure the pipe in place with approved backfill material that is tamped under and along the spring line to prevent movement. Keep the ends clear of backfill. After each section is joined, place backfill as specified to prevent movement.
    7. Mechanical joint fittings vary slightly with different manufacturers. Install the furnished fittings in accordance with the manufacturer's recommendations. In general, the procedure shall be as specified here. Clean the ends of the fittings of all dirt, mud, and foreign matter by washing with water and scrubbing with a wire brush. When the ends of the fittings are clean, slip the gland and gasket on the plain end of the pipe. If

necessary, lubricate the end of the pipe to ease sliding the gasket in place. Then guide the fitting onto the spigot of the laid pipe.

5.6.5 Cutting Pipe

a. Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner, without damaging the pipe or lining and leaving a smooth end at right angles to the axis of the pipe.
b. The contractor shall cut ductile iron pipe using a method approved by the Public Works Department authorized representative; all burrs or rough edges shall be removed before joining pipe. The contractor shall not flame-cut the pipe.
c. Dress cut ends of push-on joint pipe by beveling with a heavy file or grinder, or as recommended by the manufacturer.

5.6.6 Permissible Deflection of Joints

Wherever it is necessary to deflect the pipe from a straight line either in a vertical or horizontal plane, to avoid obstructions, or where long-radius curves are permitted, the amount of deflection allowed shall not exceed the values shown in **Table 5.1** or the manufacturer's recommendations, whichever is less.

Table 5.1. MAXIMUM PERMITTED DEFLECTION, 18-FOOT-LONG PIPE

Mechanical Joint			Push-On Joint	
Diameter (inches)	**Max. Defl. Angle (degrees-minutes)**	**Deflection[1] (inches)**	**Max. Defl. Angle (degrees)**	**Deflection[1] (inches)**
4	4° – 09′	15	3°	10
6	3° – 33′	13	3°	10
8	2° – 40′	10	3°	10
12	2° – 40′	10	3°	10

Note: Maximum deflection shall be the value shown in the table or that recommended by the pipe manufacturer, whichever is less.
[1]Safe deflection shown is for 150 psi of pressure. For higher pressure, reduce tabulated deflection 10% for each 150 psi of added pressure.

5.6.7 Alignment

Pipelines intended to be straight shall not deviate from the straight line at any joint in excess of 1 inch horizontally or 1 inch vertically.

5.6.8 Anchorage and Restraint

All pipelines 4 inches in diameter or larger shall be secured with a suitable mechanical joint restraint system (such as Megalug®, RomaGrip™, or approved equals) at all tees, plugs, caps, and bends, and at other locations where unbalanced forces exist. Where required, provide thrust blocking as specified in Subsection 5.8.10, "Thrust Blocking and Restraint." Gaskets shall be installed in accordance with Subsection 5.4.5, "Push-on Gaskets" and Subsection 5.4.6, "Flanged Gaskets."

5.6.9 Construction of Blow-offs

Blow-offs shall be constructed in accordance with these standards. Straddle blocks shall be constructed of reinforced concrete; the concrete mix shall be commercially produced and have a

compressive strength of not less than 3,000 psi at 28 days, unless otherwise approved by the Public Works Department authorized representative. Blow-offs shall not be flushed or pressurized until a minimum of 7 days after concrete is installed. If high-early cement is used for the straddle block, the time may be cut by two days.

5.6.10 Locating Wire

Install tracer wire (12-gauge with blue THNN insulation) beside the pipe. Wire shall surface at all fire hydrants, valve boxes, and blow-offs.

5.7 VALVES AND VALVE BOXES

5.7.1 Scope

This section covers the work necessary for furnishing and installing gate valves, butterfly valves, and valve boxes, complete.

5.7.2 Materials

a. Gate Valves:
   1. Resilient-seated gate valves, sized 3 inches through 12 inches, shall conform to AWWA Standard C-509 or C-515. The manufacturer's name, the model, and the year of manufacture are to be cast on each valve.
   2. Valve ends are to be flanged or mechanical joint by flanged, as shown on the plans, and conform to AWWA C-111 and ANSI Class 125. Buried service valves shall open with a counterclockwise rotation of a 2-inch operating nut.
   3. All internal parts shall be accessible without removing the body from the line. The one-piece wedge shall be completely encapsulated by resilient material. The resilient sealing material shall be permanently bonded to the wedge with a rubber tearing bond meeting the requirements of ASTM D-429.
   4. Non-rising stems (NRS) shall be cast bronze with integral collars in compliance with AWWA C-509 or C-515. The NRS shall have two O-ring seals above the thrust collar and one below. The two top O-rings are to be field replaceable (in the fully open position) without removing the valve from service. Low-friction thrust bearings shall be placed above and below the stem collar. The stem nut shall be bronze and independent of the wedge.
   5. Outside screw and yoke valves shall have a bronze stem attached to the disc assembly. An adjustable follower gland shall be incorporated to compress braided packing and seal the stem.
   6. The waterway in the seat area shall be smooth, unobstructed, and free of cavities. The cast iron body and bonnet shall be fully coated, both interior and exterior, with a fusion-bonded, heat-cured thermo setting material meeting all the application and performance requirements of AWWA C-550.
   7. Gate valves shall meet the testing requirements as presented in AWWA C-509 and C-515.

b. Butterfly Valves:
   1. Butterfly valves shall be the rubber-seated type, suitable for direct-burial service. They shall withstand 150 psi working pressure and a 150-psi pressure differential across the valve. Except as noted, the butterfly valve shall conform to AWWA C-504 for Class 150B.
   2. Valve ends are to be flanged or flanged by mechanical joint, as shown on the plans, and conform to AWWA C-111 and ANSI Class 125.
   3. All joint accessories shall be furnished with valves.

4. Valves shall be equipped with an iron body and 304 stainless-steel circular shaft. Shaft and disc seals shall be designed for a bottle-tight seal. The valve disc shall be cast iron with stainless-steel edge with acrylonitrile-butadiene (NBR) seat.
5. The butterfly valve shall be furnished with a totally enclosed, integral valve operator design to withstand a minimum of 300 foot-pound input torque without damage to the valve or operator. Operators shall be fully gasketed and greased-packed and designed to withstand submersion in water to a pressure of 10 psi. Valves shall open with a counterclockwise rotation of a 2-inch operating nut. A minimum of 30 turns of the operating nut shall be required to move the disc from a fully opened position to a fully closed position.
6. Butterfly valves shall meet the testing requirements as presented in AWWA C-504.

c. Extension Stems for Valve Operators:
   1. Where the depth of the operating nut is more than 3 feet, operating extensions shall be provided to bring the operating nut to a point 18 inches below the surface of the ground or pavement.
   2. Where the depth of the operating nut is more than 6 feet, install a second rock guard plate equidistant between the first rock guard plate and the 2" operating nut.
   3. The extension shall be constructed of solid steel rod and approved by the Public Works Department authorized representative. Cut extensions to the proper length so the valve box does not ride on the extension when set at grade.

5.7.3 Workmanship

a. Valves:
   1. Valves shall be installed in accordance with these standards. Valves shall be flanged by mechanical joint; valves shall be flanged to all tees and crosses.
   2. Before installation, the valves shall be thoroughly cleaned of all foreign material. Valves shall be inspected for proper operation, both opening and closing, and to verify that the valves seat properly.
   3. Valves shall be installed so that the stems are vertical, unless otherwise directed.
   4. Jointing shall conform to AWWA C-600 or AWWA C-603, whichever applies. Joints shall be tested with the adjacent pipeline. If joints leak under test, valves shall be disconnected and reconnected, and the valve or the pipeline or both shall be retested.

b. Valve Boxes:
   1. Valve boxes shall be installed in conformance with these standards.
   2. Center the valve boxes and set plumb over the wrench nuts of the valves. Set valve boxes so they do not transmit shock or stress to the valves. Set the valve box covers flush with the surface of the finished pavement, in conformance with these standards or to another level as may be required.
   3. Where the depth of the operating nut is more than 3 feet, operating extensions shall be provided in accordance to Subsection 5.7.2, "Materials."
   4. Valve boxes shall be the two-piece sliding type, cast iron with 6⅝ inch shaft, and shall be Vancouver-style of appropriate length for the installation, or as approved. The letter W shall be cast into the top of the lid. Extension pieces, if required, shall be the manufacturer's standard type for use with the valve box.
   5. Backfill shall be the same as specified for the adjacent pipe. Place backfill around the valve boxes and thoroughly compact it to a density equal to that specified for the adjacent trench and in such a manner that will not damage or displace the valve box from the proper alignment or grade. Misaligned valve boxes shall be excavated, plumbed, and backfilled at the contractor's expense.

6. In non-paved areas, the valve box shall be set in a concrete collar in accordance with these standards

5.8 FIRE HYDRANTS

5.8.1 Scope

This section covers the work necessary for furnishing and installing the fire hydrants, complete. Fire hydrants shall be installed in accordance with these standards.

5.8.2 Hydrants

a. Hydrants shall have a nominal 5¼-inch main valve opening with 6-inch bottom connections. The main valve shall be equipped with O-ring seals and shall open when turned left or counterclockwise.
b. The operating nut shall be a 1½-inch national standard pentagon nut.
c. Hydrants shall be equipped with two 2½-inch hose nozzles and one 4½-inch pumper nozzle with a Storz HPHA40–45NH permanent hydrant adapter, or as approved by the Fire District.
d. Hydrants shall conform to AWWA C-502 and to the City's standards. The normal depth of bury shall be 4 feet. Nozzle threads shall be American National Standard. The inlet connection shall be mechanical joint, restrained by a mechanical joint restraint system such as Megalug®, or approved equal.
e. Hydrants shall be Mueller Centurion or approved equal.
f. Hydrants shall be painted with Miller Paint Acrinamel #7323 Safety Yellow, Rust-Oleum #7645 Industrial Low V.O.C. Equipment Enamel Yellow or approved equal.

5.8.3 Base Block

The base block shall be solid precast concrete pier block with nominal dimensions of 8-inch thickness and 12-inch-square base.

5.8.4 Workmanship

Construction and installation shall conform to these standards and to the provisions of AWWA C-600, except where otherwise specified.

5.8.5 Location and Position

a. Fire hydrants shall be located in compliance with Fire District requirements. Locate as shown, or as directed, to provide complete accessibility and to minimize the possibility of damage from vehicles or injury to pedestrians. The maximum distance from a Fire District approved driving surface to a fire hydrant is 15 feet. Improperly located hydrants shall be disconnected and relocated at the contractor's expense.
b. When the hydrant is placed behind the curb or sidewalk, set the hydrant barrel so that no part of the pumper or hose nozzle cap is less than 24 inches from the face of the curb or the backside of the sidewalk.
c. Set all hydrants plum and nozzles parallel with the curb, or at right angles to it. With the pumper nozzle facing the curb, set hydrants so that the safety flange is at least 3 inches and at most 6 inches above the finished ground or sidewalk level, to clear bolts and nuts.
d. Install an approved blue bi-directional, reflectorized button one foot from the center of the near travel lane using an approved fast-setting bonding agent.

5.8.6 Excavation

Do not carry excavation below the depth necessary to install base rock and hydrant support blocks. Refill over excavated areas with gravel and compact the fill to create a firm foundation.

5.8.7 Base Rock

Place base rock on a firm, level subbase or subgrade to assure uniform support.

5.8.8 Installation of Hydrants

Place the hydrant carefully on the base block to prevent the base block from breaking. After the hydrant is in place and is connected to the pipeline, place temporary blocks to maintain the hydrant in a plumb position during subsequent work.

5.8.9 Drain Rock

Gravel for drainage shall be washed 1½" – ¾" aggregate or graded river gravel free of organic matter, sand, loam, clay, or other small particles that will restrict water flow through the gravel. Place gravel around the base block and hydrant bottom after the hydrant is blocked in place. Top of gravel shall be not less than 6 inches above the hydrant drain opening. Do not connect the drainage system to the sewer.

5.8.10 Thrust Blocking and Restraint

a. Fire hydrants shall be secured by thrust blocking. Provide reaction or thrust blocking in accordance with these standards, or as directed. Place blocking between the undisturbed ground and the fitting to be anchored. Blocking bearing surface shall be shall comply with thrust blocking requirements for waterlines.
b. Place the blocking so that the pipe and fitting joints will be accessible to repairs by wrapping all joints and fittings in new plastic sheeting (minimum 8 mil thickness).
c. The concrete mix shall be commercially produced and have a compressive strength of not less than 3,000 psi at 28 days, unless otherwise approved by the Public Works Department authorized representative.
d. Fire hydrant laterals shall be secured with a mechanical joint restraint system such as Megalug®, RomaGrip™, or approved equals.

5.8.11 Thrust Ties

Thrust ties may be used with concrete thrust blocking, with prior approval of the Public Works Department authorized representative, when the top of the existing ground behind the fire hydrant is less than 2 feet above the top of the hydrant base or where unsuitable ground prevents proper anchorage.

5.9 HYDROSTATIC TESTING AND STERILIZATION OF WATERLINES

5.9.1 Hydrostatic Testing

a. Contractor shall make pressure and leakage tests on all newly laid pipe; follow the procedures specified in AWWA C-605, Section 5.2 "Hydrostatic Testing." Contractor shall furnish all necessary equipment and material, make all taps in the pipes as required, and conduct the tests. The Public Works Department authorized representative will monitor the tests and assure that all taps are installed, and service pipe extended.
b. Furnish the following equipment and materials for the tests:

Amount	Description
2	Pressure gauges
1	Hydraulic force pump approved by the Public Works Department authorized representative

1	Suitable hose and suction, as required

c. Conduct the tests after the trench is backfilled or partially backfilled with the joints left exposed for inspection, or when completely backfilled, as permitted by the Public Works Department authorized representative. Where any section of pipe has concrete thrust blocking, do not take the pressure tests until at least five days elapse after the concrete thrust blocking is installed. If high-early cement is used for the concrete thrust blocking, the time may be cut by two days

d. Conduct pressure tests in the following manner, unless otherwise approved by the Public Works Department authorized representative. After the trench is backfilled or partially backfilled as specified here, fill the pipe with water, expelling all air during the filling. The minimum test pressure shall be 150 psi. For lines working with operating pressures in excess of 100 psi, the minimum test pressure shall be 1½ times the operating pressure at the point of testing, however, test pressure shall not exceed pipe or thrust-restraint design pressures. The duration of each pressure test shall be 2 hours, unless otherwise directed by the Public Works Department authorized representative.

   1. Procedure: Fill the pipe with water and apply the specified test pressure by pumping, if necessary. Then valve off the pump and hold the pressure in the line for the test period. Test pressure shall not vary by more than ±5 psi for the duration of the test. At the end of the test period, operate the pump until the test pressure is again attained. The pump suction shall be in a barrel or similar device or metered so that the amount of water required to restore the test pressure can be measured accurately.
   2. Leakage: Leakage shall be defined as the quantity of water necessary to restore the specified test pressure at the end of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour, as determined by the following formula:

      $$L = \frac{SD(P)^{1/2}}{133{,}200}$$

      Where: L = allowable leakage (gallons per hour).
      S = length of pipe to be tested (feet).
      D = nominal diameter of pipe (inches).
      P = average test pressure during the leakage test (psi).
   3. Correction of Excessive Leakage: Should any test of laid pipe disclose leakage greater than that allowed, locate and repair the defective joints or pipe until leakage in a subsequent test is within the specified allowance

5.9.2 Sterilization

Pipeline intended to carry potable water shall be sterilized before it is placed in service. Disinfection by chlorination for pipelines shall be accomplished according to AWWA C-651, as modified or expanded below, and City requirements. Disinfection of water-storage facilities, water treatment plants, and wells shall be accomplished according to the appropriate sections of AWWA C-651 through AWWA C-654.

a. Flushing: Before sterilizing, flush all foreign matter from the pipeline. Contractor shall provide hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damaging adjacent properties. If flushed into a sewer system, the contractor shall provide screening and remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the system at or near the closest downstream manhole; no

material shall be flushed into the downstream city sewer system. Flushing velocities shall be at least 2.5 feet per second (fps). For large-diameter pipe that is impractical or impossible to flush at 2.5 fps, clean the pipeline in place from the inside by brushing and sweeping, flush the line at a lower velocity.

b. Sterilizing Mixture:
    1. A solution with a free chlorine residual of at least 25 mg/l must be introduced to the pipe such that the solution will contact all surfaces and trapped air will be eliminated. The solution must remain in place for at least 24 hours.

5.9.3 Point of Application

a. Inject the chlorine mixture into the pipeline to be treated at the beginning of the line through a corporation stop or a suitable tap in the top of the pipeline. Water from the existing system or other approved source shall be controlled to flow slowly into the newly laid pipeline during the application of chlorine. The proportion of the flow rate of the chlorine mixture to the rate of water entering the pipe shall be such that the combined mixture shall contain 40 to 50 ppm of free available chlorine.
b. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check-valves if necessary.
c. Operate all valves, hydrants, and other appurtenances during sterilization to assure that the sterilizing mixture is dispersed into all parts of the line, including dead ends, new services, and similar areas that otherwise may not receive the treated water.
d. Do not place the concentrated quantities of commercial sterilizer in the line before it is filled with water.
e. After chlorination, flush the water from the line, see Subsection 5.9.5, "Disposal of Flushing and Sterilizing Water", until the water through the line is equal chemically and bacteriologically to the permanent source of supply.

NOTE: When testing and sterilizing procedures are complete, remove the testing corporation stop and replace it with a threaded brass plug.

NOTE: The practice of adding a small amount of chlorine powder or tablets at each joint as the main is being laid is *not* an acceptable method of chlorinating a pipeline. The procedure does not permit preliminary flushing, nor does it distribute chlorine uniformly.

5.9.4 Retention Period

After 24 hours, if the free chlorine residual is 10 mg/l or greater, the chlorine solution must be drained and the pipe flushed with potable water. If the free chlorine residual is less than 10 mg/l after 24-hours, the pipe must be flushed and rechlorinated until a free chlorine residual of 10 mg/l or more is present after a 24-hour period.

5.9.5 Disposal of Flushing and Sterilizing Water

a. Dispose of flushing and sterilizing water in a manner approved by the Public Works Department authorized representative. If the volume and chlorine concentration is such as to pose a hazard to the City's Wastewater Treatment Plant operation, the sterilizing water shall be metered into the system per direction of the Public Works Department authorized representative. Notify the Public Works Wastewater Division at least 24 hours or one business day before disposing of sterilizing water into the City sanitary system.
b. Do not allow sterilizing water to flow into a waterway or storm line without reducing the chlorine to a safe level via adequate dilution or another neutralizing method, as approved by the Public Works Department authorized representative.

5.9.6 Bacteria Testing *(New 01/04/19)*

a. After the pipe is disinfected, flushed and filled with potable water, bacteriological samples must be collected to determine the procedures' effectiveness. At least two samples must be collected from the new pipe at least 16 hours apart and analyzed for coliform bacteria. If the pipe has held potable water for at least 16 hours before sample collection, two samples may be collected at least 15 minutes apart while the sample tap is left running. If the results of both analyses indicate the water is free of coliform bacteria, the pipe may be put into service. If either sample indicates the presence of coliform bacteria, the pipe may be re-flushed, filled with potable water and re-sampled. If this second set of samples is free of coliform bacteria, the pipe may be put into service, otherwise the disinfection and flushing process must be repeated until samples are free of coliform.

5.10 WATER SERVICE CONNECTIONS

5.10.1 Scope

The work includes trench excavation and backfill, furnishing and installing service saddles, corporation or valves, meter vaults or boxes, meters, service connection piping, fittings, and appurtenances within the designated limits, testing, flushing, and other incidental work as required for a complete installation.

5.10.2 Hydrostatic Test and Leakage

Test service connections and service connection pipe in conjunction with the main, as detailed in Subsection 5.9.1, "Hydrostatic Testing".

5.10.3 Materials

a. Service Lines and Fittings ¾-inch and 1-inch: Single service lines, ¾-inch or 1-inch, shall be blue or clear potable water Wirsbo PEX pipe or approved equal service lines. All service line fittings shall have ProPEX fittings.
b. Service Lines 1.5-inch to 2-inch: All service lines 1.5 inch to 2-inch shall be blue or clear potable water Wirsbo PEX pipe or approved equal service lines. All service line fittings shall have ProPEX fittings.
c. Service Lines Larger Than 2-inch: All service lines needs greater than 2-inch shall be in increments of 4-inch, 6-inch, and 8-inch and shall be C-900 pipe.
d. Service Saddles ¾-inch to 2-inch: Service saddles shall be Romac 202NS service saddle or approved equal. Saddle casting must be black or blue nylon or epoxy coated, and both straps must be Type 304 (18-8) heavy gauge Stainless Steel per ASTM A-240.
e. Service Connections Greater Than 2-inch: All service connections greater than 2-inch shall be made with a FL by MJ tee and FL by MJ gate valve. Gate valve shall be connected directly to the tee. No spools will be allowed between the tee and gate valve.
f. Meter Boxes and Covers: Generally, meter boxes and covers are installed in landscape areas and shall be of the type indicated in **Table 5.3**, Pedestrian Rated, or approved equal. Occasionally, with the approval of the Public Works Department authorized representative, installation of meter boxes in driveway areas may be allowed. In these cases, meter boxes and covers shall be of the type indicated in **Table 5.3**, Traffic Rated, or approved equal. In all cases, any meter box installed in pavement shall have a full faced, steel, traffic rated removable lid. All boxes shall be ordered with a 3" x 6" mouse hole precut into one end of the box.

Table 5.3. METER BOXES AND COVERS

Service Line	Right-Of-Way and Public Utility Easement

	Meter Box	Meter Box Cover	Meter Box Lid
3/4- inch and 1-inch (not set in pavement)	Brooks No 37. MB	No. 37 - S	No. 37 - S LID (1-S) **steel**
1.5-inch and 2-inch (not set in pavement)	Brooks No. 66 MB	No. 66 - S	No. 66 - ST LID (3-T) **steel**
3/4-inch to 2-inch service **if set in pavement** (Traffic Rated)	Brooks No. 66 MB	**NA**	No. 66 - T Steel Cover (Superimposed)

g. Corporation Stops: 1-inch corporation stops shall brass Mueller H-15028 (110 Compression) for saddle taps or approved equal.
h. Angle Valves: Shall be brass Mueller H-14255 angle curb stop, Ford No. KV23-444W for ¾-inch and 1-inch line, and Mueller No.14276 or Ford No. FV 23-777W for 1½-inch and 2-inch line or approved equal.

5.10.4 Workmanship

a. Trench Excavation, Preparation, and Backfill: Trench excavation, preparation, and backfill shall conform to the requirements of Section 6, "Trench Excavation and Backfill Standards." Backfill material in the trench to within 6 inches of service connection pipe or line. Cover over pipe shall be in accordance with these standards
i. Connection to Main: Service connections shall be installed in accordance with these standards. Taps shall be made in the pipe by experienced workmen, using tools in good repair, with proper adapters for the size of pipe being tapped. Line taps shall be 30° above the horizontal for 1" service connections and centered on the spring line of the pipe being tapped for 1½" or 2" service connections. Tap shall be made no closer than 18 inches from the outside edge of the sleeve to the beginning of the bell flare or end of the MJ fitting. The Public Works Department authorized representative shall be notified and shall be present during tapping of City water main, unless otherwise approved by the Public Works Department authorized representative.
b. Installation of Meters and Meter Boxes:
    1. Meters and meter boxes or vaults shall be installed in accordance with these standards, or as directed by the Public Works Department authorized representative.
    2. City of Molalla Water Division shall install all meters 2 inches in diameter or less. Meters larger than 2 inches in diameter shall be installed by the contractor under the supervision of City of Molalla Water Division.
    3. Meters shall not be installed until the entire water system is ready for operation, the system has been tested and approved, and water meter permit(s) have been obtained from the City of Molalla Building Division.
    4. The remainder of the service connection, excluding the meter, may be installed at any time during or after construction of the main. Before the meter is connected, the angle valve shall be opened, and the service line flushed of all foreign materials, and shall be properly tested and chlorinated.

5. The finish grade of the completed meter enclosure shall allow a minimum of 6 inches and a maximum of 12 inches of clearance from the top of the meter to the meter box. Meter boxes or vaults shall be set or constructed plumb, with the top set horizontally. Lightly compacted earth backfill shall be placed inside the meter boxes to the bottom of the meter stop. Grade adjustments of the meter boxes or vaults shall be made by using standard extension sections for the specified box or vault. Backfill around meter vaults shall be as specified for adjoining pipe. Provide adequate space to allow for sidewalk installation. Under no circumstances shall meter boxes be placed in the sidewalk.
6. Depending on the elevation difference between the meter and the main line water system working pressure, the City may require a backflow-prevention valve and/or a pressure reducing valve on the customer side of the meter, at the meter box. Installation shall be approved by the Public Works Department authorized representative.

5.11 WARRANTEES AND ACCEPTANCE

5.11.1 Activation

The City of Molalla will provide water to the project when the following are complete.

a. Compliance with these standards.
b. Installation of the materials and workmanship as described herein.
c. Successful hydrostatic pressure tests, as witnessed and approved by the Public Works Department authorized representative.
d. Adequate flushing and chlorination of mains.
e. Approval by an Oregon Health Division certified water quality laboratory of samples taken for bacteriological examination.

5.11.2 Legal Recordings

Dedication of any required easements or rights-of-way have been recorded with the County Recorder and the Engineering Department receives a reproducible copy of the recorded documents.

5.11.3 Project Completion

After completion of construction of the total project, and after all testing has been satisfactorily completed, project closeout shall proceed as outlined in Subsection 1.17.17, “Project Closeout.”

5.11.4 Maintenance Period

a. The Contractor or Applicant shall be responsible for providing Maintenance Assurance for Public Improvements as outlined in Subsection 1.17.18, “Maintenance Assurance and Warranty.” Public water improvements shall be warranted for a minimum of one year; public landscape improvements shall be warranted for a minimum of two years.
b. At any time during the warranty period, the Public Works Department authorized representative has reason to believe the public water improvements have defects that were the result of faulty workmanship or flaws in construction material, the responsible party shall be required, at that party’s own cost, to repair any problems or faults to the public water improvements deemed necessary by the Public Works Department authorized representative.
c. Before the end of the Construction Maintenance period, the City's authorized representative shall inspect the project for any remaining deficiencies. If the deficiencies that remain are determined to be the responsibility of the contractor or the applicant, the contractor or applicant shall then make such repairs.

d. The Landscape Maintenance assurance shall be released two years after acceptance of construction, providing the landscaping meets the 90% survival level (see Subsection 3.13.2, “Landscape Inspection for Warranty”)

SECTION 6 – TRENCH EXCAVATION & BACKFILL STANDARDS

6.1 DEFINITIONS

COMMON EXCAVATION – Defined as the removal of all material that is not classified as rock excavation. The term "rock excavation" shall be understood to indicate a method of removal and not a geological formation.

HAUNCH – That portion of the pipe below the spring line.

NATIVE MATERIAL – Earth, gravel, rock, or other common material free of humus, organic matter, vegetative matter, frozen material, clods, sticks, and debris, isolated points or areas, or larger stones that would fracture or dent the structure or subject it to undue stress.

PIPE BEDDING – The furnishing and placing of specified materials on the trench foundation to uniformly support the barrel of the pipe, from the trench foundation to the spring line of the pipe.

PIPE ZONE – The full width of the trench, from 12 inches above the top outside surface of the barrel of the pipe to the spring line of the pipe.

ROCK EXCAVATION – Defined as the removal of material that cannot, in the Public Works Director's judgment, be reasonably excavated with equipment comparable in machine weight and rated horsepower to a hydraulic hoe excavator with a minimum weight of 45,000 pounds and a net horsepower rating of 130 to 140. Rock excavation is also the removal of material by drilling and blasting (see "Explosives" in Subsection 6.3.1, "Excavation," for blasting restrictions) or power-operated rock-breaking equipment. Boulders or concrete pieces larger than ½ cubic yard encountered in the trench excavation shall be classified as rock excavation if removing them requires any of the above excavation methods, in the opinion of the Public Works Department authorized representative.

SPRING LINE – Halfway up the sides of the pipe (horizontal centerline) when the pipe is laid on the pipe bedding.

TRENCH BACKFILL – The furnishing, placing, and compacting of material in the trench between the top of the pipe zone material and the bottom of the pavement base rock, ground surface, or surface materials.

TRENCH EXCAVATION – Trench excavation is the removal of all material encountered in a trench to the depths shown on the plans or as directed by the Public Works Department authorized representative. Trench excavation shall be classified as either common or rock excavation.

TRENCH FOUNDATION – The bottom of the trench on which the pipe bedding will lie. The trench foundation supports the pipe bedding.

6.2 MATERIALS

6.2.1 Trench Foundation

Trench foundation shall be native material in all areas except where groundwater or other conditions exist, and, in the opinion of the Public Works Department authorized representative, the native material cannot support the bedding and pipe. Under those conditions, geotextile fabrics approved by the Public Works Department authorized representative shall be installed, or the unsuitable material shall be removed, as determined by the Public Works Department authorized representative, and the trench foundation backfilled with Class B backfill.

6.2.2 Pipe Area

a. Pipe bedding material shall be Class B backfill, uniformly graded from course to fine, or as approved by the Public Works Department authorized representative.
b. Pipe Zone material shall consist of Class B backfill.

6.2.3 Trench Backfill

Above the pipe zone, trench backfill will be divided into the following classifications (from ODOT SSC)

a. Class A Backfill: Class A backfill shall be native or common material, which in the opinion of the Public Works Department authorized representative meets the characteristics required for the specific surface loading. Selected trench fill material shall contain no frozen soil, gravel, or cobbles larger than 6 inches in diameter, and shall be free of organic or other deleterious material.
b. Class B Backfill: Class B backfill shall be ¾"-0" granular grade crushed aggregate material, unless otherwise approved by the Public Works Department authorized representative. The aggregate shall conform to the following.
    1. The aggregate shall consist of uniform-quality, clean, tough, durable fragments of rock or gravel and shall be free of flat, elongated, soft, or disintegrated pieces, or other objectionable matter occurring either free or as a coating on the stone.
    2. The aggregate shall meet the requirements for fractured faces and durability as specified in ODOT SSC Section 02630.10 "Dense-Graded Aggregate."
    3. Gradation and plasticity index requirements of the crushed aggregate shall be as shown for ¾"-0" rock in **Table 2.11**, "Gradation Requirements of Granular Backfill."
    4. Class B backfill material shall be approved by the Public Works Department authorized representative prior to placement.

6.3 CONSTRUCTION

6.3.1 Excavation

a. Clearing and Grubbing: When clearing the right-of-way is necessary, clearing shall be completed before the start of trenching. Clearing and grubbing shall follow the procedures outlined in Subsection 2.5.2, "Clearing and Grubbing." Under no condition shall excavated materials be permitted to cover brush before the brush is cleared and disposed of. Excavated material shall be stockpiled where, and so it does not create a hazard to, pedestrian or vehicular traffic; nor shall it interfere with the function of existing drainage facilities.
b. Erosion Control: The contractor shall be responsible for erosion prevention and sediment control on the jobsite and shall use appropriate prevention measures as outlined in Subsection 1.18.4, "Erosion Prevention and Sediment Control." The contractor shall maintain the erosion-prevention and sediment-control facilities as specified in Subsection 1.18.5, "Maintenance."
c. Interferences and Obstructions: Various obstructions may be encountered during the course of the work. The contractor shall follow the guidelines established in Subsection 1.17.5, "Interferences, Obstructions, and Abandoned Utilities."
d. Open Trench Limit
    1. Construction shall proceed in a systematic manner that will result in minimum inconvenience to the public. Construction staking for the work being performed shall be completed before the start of excavation.
    2. The contractor shall limit their operations to a small work area per crew. The length of the excavated trench shall always be kept to a minimum. At no time shall the trenching equipment be farther than 100 feet ahead of the pipe-laying crews, unless advance written permission is given by the Public Works Department authorized representative.
    3. The trench shall be backfilled so that no section of trench is left open longer than 24 hours. Before the contractor stops construction for the day, trenches located in the

right-of-way shall be completely backfilled, unless the trench is covered with Steel Plates. Use of Steel Plates shall conform to Subsection 1.17.2, "Progress of Construction."

e. Trench Width
    1. The trench width at the surface of the ground shall be kept to the minimum necessary to safely install the pipe. All aspects of excavation, trenching, and shoring shall meet current OSHA standards and regulations. In all cases, trenches must be wide enough to allow for shoring and to permit proper joining of the pipe and backfilling and compaction of material along the sides of the pipe.
    2. Trench width in the pipe zone must provide a minimum clear working space outside the maximum outside diameter of the pipe. Minimum clear working space shall be 6 inches for pipe up to 12-inch interior diameter; for pipe greater than 12-inch interior diameter the minimum clear working space shall be ½ the inside pipe diameter up to a maximum of 24 inches. Excavation for manholes and other structures shall be wide enough to provide at least 12 inches between the structure's surface and the sides of the excavation or shoring.
    3. Maximum width of the trench at the top of the pipe shall be 12 to 24 inches plus the width of the pipe bell. When required by the project design, the maximum trench width shall be shown on the plans.
    4. If the contractor exceeds the maximum trench width shown on the plans without written authorization, the contractor shall be required to contact the design engineer or the geotechnical engineer and obtain written approval allowing installation of the pipe as specified, or contractor shall provide, at their cost, pipe of a higher strength designation, a higher class of bedding, or both, as recommended by the design engineer or the geotechnical engineer, and approved by the Public Works Department authorized representative.
    5. The contractor shall confine the top width of the trench to rights-of-way or easements. If circumstances require extending the width of the trench beyond the right-of-way or easement boundary, the applicant shall obtain written agreements with the affected property owner(s) and provide them to the Public Works Department authorized representative before commencing excavation.

f. Grading
    1. The bottom of the trench shall be graded to the line and grade to which the pipe is to be laid, with proper allowance for pipe thickness and bedding material, or for greater base when specified or indicated. Before laying each section of the pipe, check the aggregate grade and correct any irregularities.
    2. The trench bottom shall form a continuous and uniform bearing surface and support the pipe on solid and undisturbed ground at every point between bell holes, except that the grade may be disturbed for removing lifting tackle.

g. Rock Excavation
    1. Where the bottom of the trench encounters ledge rock, boulders, or large stones that meet the definition of "rock excavation," rock excavation shall be performed to create six inches of clearance on each side and below all pipe and accessories.
    2. Excavations below subgrade in rock shall be backfilled to subgrade with Class B backfill material and compacted to not less than 90% of its maximum dry density as determined by AASHTO T-180.

h. Explosives
    1. Explosives shall not be used in the City of Molalla without prior written approval from the Public Works Director.

6.3.2 Installation

a. Shoring
    1. The contractor shall provide all materials, labor, and equipment necessary to adequately shore trenches to protect the work, existing property, utilities, pavement, etc., and to provide safe working conditions in the trench.
    2. Cribbing or sheeting that extends below the spring line of rigid pipe or below the crown elevation of flexible pipe shall be left in place, unless a satisfactory means can be demonstrated for reconsolidating bedding or side support that would be disturbed by removing the cribbing or sheeting.
    3. If a movable box is used instead of cribbing or sheeting and the bottom cannot be kept above the spring line of the crown elevation of the flexible pipe, the bedding or side support shall be carefully reconsolidated behind the movable box before backfill is placed.
    4. The use of horizontal strutting below the barrel of pipe, or the use of pipe as support for trench bracing, will not be permitted.
b. Dewatering
    1. The contractor shall provide and maintain ample means and devices for promptly removing and disposing of all water entering the trench excavation while the trench is prepared for pipe laying, during the laying of the pipe, and until the backfill is placed and compaction is complete.
    2. Groundwater shall be controlled to keep it from softening the bottom of the excavation. Dewatering systems shall be designed and operated to prevent removal of the natural soils and to keep the groundwater level outside the excavation from being reduced to an extent that would damage or endanger adjacent structures or property.
    3. Dewatering systems shall be discharged to a stormwater detention/retention facility unless otherwise approved by the Public Works Department authorized representative.
c. Grade
    1. The contractor shall excavate the trench a minimum of 6 inches plus the pipe wall thickness below the specified pipe grade, or as established by the geotechnical engineer. The subgrade on which the bedding is to be placed shall be firm, undisturbed, and true to grade.
d. Trench Foundation
    1. When in the judgment of the geotechnical engineer or the Public Works Department authorized representative, the existing material in the bottom of the trench is unsuitable to support the pipe, the contractor shall excavate below the pipe, as directed.
    2. The contractor shall backfill the trench to the subgrade of the pipe bedding with Class B backfill material over the full width of the trench and shall compact in layers not exceeding 6 inches deep.
    3. Fill material shall be compacted to not less than 90% of its maximum dry density, as determined by AASHTO T-180.
e. Pipe Bedding
    1. Class B backfill material shall be placed under all pipes.
    2. Pipe bedding consists of leveling the bottom of the trench on the top of the foundation material and placing bedding material to the horizontal centerline of the pipe, unless otherwise specified.

3. Granular base shall be placed in the trench to a depth of 6 inches, loose, for the full width of the trench. The contractor shall spread the bedding smoothly to the proper grade, so the pipe is uniformly supported along the barrel.
4. The contractor shall excavate bell holes at each joint to permit proper assembly and inspection of the entire joint. Bedding under the pipe shall provide firm, unyielding support along the entire pipe length.
5. Contractor shall be aware of the importance in proper placement and compaction of backfill material placed below the spring line of the pipe (haunch area). Proper backfilling ensures that adequate stability and support is provided to the pipe during final backfilling of the pipe zone. Backfill material shall be worked under the haunches by hand.

f. Backfill in Pipe Zone
   1. After the pipe is in place and ready for backfilling, place Class B backfill to a minimum depth of 12 inches over the top of the pipe. The material shall be placed at approximately the same rate on each side of the pipe, so that the elevation of the aggregate on each side of the pipe is always equal.
   2. Particular attention shall be given to the backfilling and tamping procedure to assure that there are no unfilled or non-compacted areas under the pipe.

g. Trench Backfill
   1. Backfill shall be placed in the trench in such a way as to not permit material to freefall until the top of the pipe is covered by at least 2 feet of material. Under no circumstances shall the contractor allow sharp, heavy objects to drop directly onto the pipe or pipe zone material around the pipe.
   2. If the required compaction density cannot be obtained, the contractor shall remove the backfill from the trench and recompact. The process shall be repeated until the contractor establishes a procedure that will provide the required density. The contractor will then be permitted to proceed with backfilling and compacting the rest of the pipeline under the approved compaction procedure.
   3. Within the public right-of-way, trench backfill shall consist of granular fill meeting the requirements of Subsection 2.3.1, “Granular Fill.”

h. Native or Select Class A Backfill
   1. Backfill the entire depth of the trench above the pipe zone with excavated trench materials placed in 12-inch layers. Remove all cobbles and stones 2 inches in diameter and larger from material used for backfill in the upper 12 inches of the trench.
   2. Compact each layer using mechanical tampers or vibratory compactors to 85% of its maximum dry density, as determined by AASHTO T-180. Bring the fill to the required surface grade, and compact so that no settlement will occur.

i. Granular Backfill
   1. Granular backfill material shall meet the requirements of Subsection 2.3.1, “Granular Fill.” Granular backfill shall be tested at a minimum of every 200 feet of trench length and at depths specified by the Public Works Department authorized representative.
   2. The aggregate backfill within 2 feet of base grade shall be compacted to not less than 95% of its maximum dry density, as determined by AASHTO T-180. Backfill placed more than 2 feet from base grade shall be compacted to not less than 90% of its maximum dry density.

SECTION 7 – BICYCLE & PEDESTRIAN FACILITY STANDARDS

7.1 INTRODUCTION

The purpose of this Section is to outline the design and construction requirements for bicycle and pedestrian improvements in the City of Molalla. The City regards facilities for bicyclists and pedestrians as important parts of the overall transportation system and not just recreational facilities and shall continue to improve and expand pedestrian and bicycle facilities, with a focus on improved connectivity between major activity centers while minimizing conflicts with other modes of transportation.

Bicycle and pedestrian facilities are addressed in the City of Molalla's TSP and the 2014 City of Molalla Parks, Recreation, and Trails Master Plan (PRTMP).

7.1.1 Bicycle and Pedestrian Facility System

To encourage bicycling and walking in the City, it is critical to provide safe and convenient systems that connect residential, commercial, and industrial destinations. Therefore, collector and arterial street design shall include bicycle facilities on or near the streets. Sidewalks shall be provided on (preferred) or near all streets. The multi-use path system shall be expanded to provide off-street pathways and trails for convenience, safety, and recreation.

7.1.2 Playground Facilities

Playground facilities shall be designed in conformance to the Consumer Product Safety Commission Handbook for Public Playground Safety, or latest edition.

7.2 DESIGN OF BICYCLE AND PEDESTRIAN FACILITIES

7.2.1 General Design, Location, and Easement Requirements

a. Design: The design of all bicycle and pedestrian facilities within the City of Molalla shall be in conformance with applicable AASHTO, ODOT, and ADA requirements and standards, as provided in the 1999 AASHTO publication, "Guide for the Development of Bicycle Facilities," the 1995 ODOT publication, "Oregon Bicycle and Pedestrian Plan," and ADA Standards for Accessible Design, as amended in 1994, or latest editions. For areas not fully addressed in the ADA Standards, the ADA Accessibility Guidelines (ADAAG), as amended in 2002, or the 2011 Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way, designs modifications will be approved as determined by the Public Works Department authorized representative. Any deviation from the AASHTO, ODOT, ADA, or City standards shall require written approval from the Public Works Department authorized representative.

b. Location: Bicycle and pedestrian facilities shall be installed on the basis of the City of Molalla's TSP and PRTMP. In case of conflict, however, the PRTMP takes precedence in matters dealing with off-street facilities.

c. Right-of-Way and Easements
    1. All public-owned bicycle facilities shall be constructed within a public right-of-way or easement. When a bicycle facility must be constructed outside the public right-of-way, an appropriate easement shall be granted to the City for construction and maintenance of the facility; the location and width of the easement shall be approved by the Public Works Department authorized representative. A temporary construction easement may also be required.
    2. All new development or redevelopment within the City shall provide an easement to access adjacent streets, neighborhoods, and properties, especially schools, retail, and

commercial areas. The intent of the easements is to reduce the length of travel to desired destinations from residential areas, thereby promoting bicycle/pedestrian travel.

7.2.2 On-Street Design Standards

a. Design Standards: On-street standards for different situations are described below. It is recommended that bicycle lanes be the preferred facility design on state highways, arterials, and collectors unless the posted speed limit is 30 MPH or less. Other facility designs should be used only if the bicycle lane cannot be constructed to the standard because of physical constraints. The alternative standards are listed in order of preference.
   1. Bicycle Lane
      (a) Bicycle lanes shall always be one-way facilities and carry bicycle traffic in the same direction as adjacent motor vehicle traffic.
      (b) The design shall include 10-foot minimum travel lanes for motor vehicles with 5-foot paved shoulders, or 5-foot paved lanes where on-street parking is allowed that are striped, marked, and signed as bicycle lanes.
      (c) There shall be a minimum clear riding zone of 3.5 feet if there is a longitudinal joint between asphalt pavement and concrete gutter. Additional widths are recommended where substantial truck traffic is present, on grades, or where motor vehicle speeds exceed 35 miles per hour.
      (d) This shall be the basic standard applied to bicycle lanes on all arterial and collector streets owned and operated by the city. Bicycles lanes on county and state owned and operated roadways shall meet the standards of that jurisdiction.
   2. Shoulder Bikeway: This design includes a 10-foot minimum travel lane for motor vehicles with 5-foot paved shoulders that are striped but not marked as a bicycle lane. This should only be used in rural situations when it is determined by the Public Works Department authorized representative that a marked bicycle lane is inappropriate.
   3. Shared Roadway: This design features minimum 12-foot travel lane widths for both motor vehicles and bicycles. This standard should be applied to all arterial and collector streets only when sufficient pavement width is not available for a separate bicycle lane and posted speed limits do not exceed 30 MPH. On arterial and collector streets, bicycle route signage is required to alert motorists to the potential presence of bicyclists.

b. Drainage Grates
   1. Drainage grate inlets and utility covers are potential problems for bicyclists. When a new roadway is designed, all such grates and covers shall be kept out of bicyclists' expected path.
   2. On new construction, curb inlets shall be used wherever possible to completely eliminate the exposure of bicyclists to grate inlets.
   3. Grates and utility covers shall be adjusted flush with the surface, including after a roadway is resurfaced.
   4. Grates shall be identified with a pavement marking, as indicated by the MUTCD, Part 9, or latest edition. Drainage grate inlets shall be bicycle-safe (as required by ORS 810.150) and hydraulically efficient.

c. Railroad Crossings
   1. Railroad-highway/multi-use path grade crossings should meet at right angles. The greater the approach angle deviates from 90^{o}, the greater the potential for a bicyclist's wheel to be trapped in the railroad flange-way.

2. Where the crossing angle is less than 45°, consideration shall be given to widening the outside lane, shoulder, or bicycle lane to allow bicyclists adequate room to cross the tracks close to a 90° angle.
3. In the case of multi-use path crossings, centerline stripes shall be provided to encourage a right-angle approach. Where these options are not possible, commercially available compressible flange-way fillers shall be installed.
4. The roadway approach shall be at the same elevation as the rails.
5. Warning signs and pavement markings shall be installed in accordance with the MUTCD, Part 9.

7.2.3 Off-Street Design Standards

a. Bicycle and Pedestrian (Multi-use) Path: Multi-use paths are facilities on exclusive rights-of-way or easements. These facilities are physically separated from the roadway and are designed to exclude motor vehicle traffic, except at crossings. Separation shall be obtained by a barrier or by a minimum of 5 feet of open space. It is the City's policy not to illuminate multi-use paths.
   1. Width of Multi-use Paths: Paths shall have a minimum width of 10 feet for two-way multi-use traffic and 12 feet where high multi-use traffic is expected. In addition, a minimum 2-foot clear distance on both sides of the path is required, although a 3-foot side clear distance is preferred. The maximum gradient for side clear areas shall be 6H:1V.
   2. Overhead Vertical Clearance: Overhead vertical clearance shall be a minimum of 8 feet. However, vertical clearance shall be a minimum of 10 feet where vehicular traffic is expected and in under-crossings or tunnels.
   3. Horizontal Curves and Sight Distance:
      (a) Multi-use path horizontal curves shall have a minimum 35-foot centerline curve radius.
      (b) Corner sight distance shall be a minimum of 25 feet.
      (c) When substandard radius curves must be used on multi-use paths because of right-of-way, topographical, or other considerations, standard curve warning signs and supplemental pavement markings shall be installed in accordance with the MUTCD, Part 9. The negative effects of substandard curves can be partially offset by widening the pavement through the curve and removing objects that impair sight distance.
   4. Drainage: The minimum pavement cross slope shall be 2%. Curves shall be banked with the low side on the inside of the curve. Paths constructed along hillsides shall have an interceptor ditch of suitable dimension on the uphill side.
   5. Super-elevation Rate: For most multi-use path applications, the super-elevation rate (i.e., a raised elevation of one side of the path) will vary from a minimum of 2% (the minimum necessary to encourage adequate drainage) to a maximum of 5% percent (beyond which maneuvering difficulties by slow bicyclists and adult tricyclists might be expected). The minimum super-elevation rate of 2% will be adequate for most conditions and will simplify construction.
   6. Grade:
      (a) Grades on multi-use paths shall be kept to a minimum, especially long inclines, and are recommended to be no greater than 5%.
      (b) Where terrain dictates, grades over 5% and less than 500 feet in length are acceptable only when consideration has been given to sight distance and stopping

distances. In areas of generally steep terrain, it may be desirable to meander path alignments to attain reasonable grades for steep slope ascent.

(c) In no case shall a "down-hill" approach grade of the intersection of a multi-use path to a sidewalk or street exceed 5% for the last 50 feet unless provisions have been made to provide satisfactory sight vision between the two intersecting facilities.

(d) Grade changes on pathways shall provide for a minimum pedal clearance of 6 inches. If use by pedestrians is expected, ADA requirements must be met.

7. Structures:
   (a) Multi-use paths constructed along hillsides or next to drainage ditches steeper than 3H:1V shall be protected with an approved handrail system in conformance with these standards.
   (b) Bridges designed exclusively for bicycle and pedestrian traffic shall be designed for pedestrian live loadings. Bridge width shall be the total of the path width plus the side clear distances. Bridge decks shall be designed with bicycle safe expansion joints. Decking boards shall be placed transverse to the direction of normal bike travel and shall be coated with a nonskid surfacing material approved by the City's Public Works Department.
   (c) Where gravel driveways cross the path, a 5-foot paved apron shall be provided to minimize the transfer of gravel to the pathway.
8. Pavement Design:
   (a) Subgrades shall be sterilized with a suitable non-environmentally hazardous herbicide that is approved by the City of Molalla Public Works Department to prevent subsequent intrusion of hardy weeds, vines, or other plant material into or upheaving through path surfaces.
   (b) Additional asphalt, base rock, and subgrade reinforcement shall be provided in path sections projected to bear heavy maintenance vehicle traffic. No less than one additional inch of asphalt shall be provided in these areas.
   (c) The wearing surface of AC pavement shall conform to ODOT SSC Section 00745, "Hot Mixed Asphalt Concrete" for Level 1 HMAC. Pavement design shall be a minimum of 3 inches of AC pavement over a 4-inch thick base consisting of ¾"–0" crushed aggregate backfill, meeting requirements of Subsection 2.3.1, "Granular Fill." Base rock shall be compacted to 95% of the maximum dry density as determined by AASHTO T-180. Base rock shall be placed over a firm subgrade stripped as per Subsection 2.5.2, "Clearing and Grubbing."
   (d) PCC pavement shall be an acceptable path surface alternative. The surface shall be broom finished and crack-control joints shall be saw-cut, not troweled. Minimum design thickness shall be 4 inches of PCC over a 2-inch base consisting of ¾"–0" crushed aggregate backfill, meeting requirements of Subsection 2.3.1, "Granular Fill." Base rock shall be compacted to 95% of the maximum dry density as determined by AASHTO T-180. Base rock shall be placed over a firm subgrade stripped as per Subsection 2.5.2, "Clearing and Grubbing."
   (e) Location of expansion and contraction joints in PCC multi-use paths shall be approved by the Public Works Department authorized representative. All expansion joints, paving joints, driveway intersections, and railroad crossings shall be designed to maintain a smooth riding surface.
   (f) Pathways in close proximity to trees shall be protected from root intrusion as per "Root Barriers" in Subsection 2.2.27, "Curb and Grading Outside of Street."
9. Public Easements and Rights-of-Way: The City, through the development application process, may require the granting of a public easement for multi-use paths. Where it is

deemed to be in the best interests of the City, a dedication of right-of-way may be required in lieu of an easement. Bike path easements and rights-of-way shall be no less than 15 feet wide, or wider as determined by the City in accordance with the following:
    (a) Where terrain dictates cut or fill sections to meet path design requirements, additional width shall be required only to the extent necessary for sides lopes

b. Recreational Trail: This is an ADA accessible surface with a usable width of 4 to 6 feet conforming to the ADA Standards for Accessible Design requirements. It is the City's policy not to illuminate recreational trails.
c. Landscaping:
    1. Landscaping shall be provided along multi-use paths and recreational trails. Selection of trees, shrubs, and ground cover should include low-maintenance varieties that are drought tolerant and require little pruning. Shrubs should be low growing (under 3 feet at mature height). Location and placement of plant materials should not result in growth over or onto the path surface.
    2. All proposed plant materials shall be approved by the City of Molalla. All landscaping, signs, and other potential obstructions shall be set back a minimum of 1 foot from the edge of the pathway surface. No exposed rock shall be permitted within 2 feet of the pathway surface. All exposed earth within 2 feet of the pathway surface shall be planted with grass, sod, or covered with 2" of bark dust.
    3. A number of important design considerations should be reviewed when selecting materials and planning planting schemes. Trees are of primary concern regarding location and variety. Specifically, placement and selection of trees should evaluate the following:
        (a) Tree rooting characteristics - to avoid potential path surface upheaval.
        (b) Tree size - trees shall be of satisfactory caliper to permit a minimum vertical clearance of 8 feet to the lowest branch. The clearance shall be a minimum of 10 feet where vehicular traffic is expected.
        (c) Tree placement - to avoid creating hiding areas and future site distance issues.
d. Root Control: Pathways shall be protected from root intrusion as per "Root Barriers" in Subsection 2.2.27, "Curb and Grading Outside of Street."

7.2.4 Sidewalks

a. The location, design, and construction of sidewalks shall be in conformance with Subsection 2.2.28, "Sidewalks."
b. Special Design Standards: The physical environment shall be enhanced to encourage bicycling and walking by following these standards:
    1. Minimum sidewalk width shall be in conformance with Subsection 2.2.28, "Sidewalks."
    2. Issues should be addressed to encourage walking by providing a more pleasant environment. Urban design features to provide pedestrian amenities such as street trees, furniture, kiosks, trash receptacles, directional signage, and bicycle amenities such as bike racks, shall be provided when required by the City.
    3. Pedestrian facilities shall be consistent with the ADA Standards for Accessible Design.

7.2.5 Signing and Marking

a. All pathways and bicycle route shall be clearly identified and posted with signs are a common method for identifying bicycle routes. Signing and marking of bikeways are important in providing safety to users and shall be in conformance with the MUTCD, Part 9.
b. On multi-use paths, adequate signing and marking shall be used to alert users to potential hazards and to convey regulatory messages to bicyclists, pedestrians, and motorists at

highway intersections. In addition, guide signs, such as to dictate directions, destinations, distances, route numbers, and names of crossing streets, shall be used in the same manner as they are used on highways.

c. On multi-use path areas where limited sight vision or curves exist, or where heavy volumes of bicycles or nighttime riding is expected, a 4-inch wide yellow centerline stripe shall be used. Four-inch wide white edge lines (or fog lines) shall be used where nighttime bicycle traffic is expected. Skid-resistant pavement marking materials shall be used over materials that become slippery when wet.

7.3 TRAFFIC CONTROL

a. At intersections where bicycle traffic exists or is anticipated, bicycles shall be considered in the timing of the traffic signal cycle, as well as the traffic detection device.

b. To check the clearance interval, a bicyclist's speed of 10 miles per hour and a perception/reaction/braking time of 2.5 seconds shall be used. Detectors for traffic-actuated signals shall be sensitive to bicycles and shall be located in the bicyclist's expected path, including left-turn lanes. Where programmed visibility signal heads are used, they shall be checked to ensure that they are visible to bicyclists who are properly positioned on the road.

c. The MUTCD, Part 9, and the Oregon Supplement shall be consulted for guidance on signs and pavement markings. Where bicyclists are expected to use different patterns than motorists, direction signing shall be used to advise bicyclists of this special routing. At intersections, bicyclists proceeding straight through and motorist turning right must cross paths. It is recommended to use striping and signing configurations that encourage these crossings in advance of the intersection, in a merging fashion.

7.4 SUPPORT FACILITIES

In addition to improving public facilities and routes to connect destinations, the City requires basic design considerations for bicyclists and pedestrians when they arrive at their destination. City requirements for the following support facilities can be found in the PRTMP and City zoning code:

a. On-site Bicycle and Pedestrian Circulation for all New Developments.
b. Bicycle and Pedestrian Paths.
c. Bicycle Parking Requirements.
d. Bicycle Lockers or Other Secure Parking Facilities
e. Locational Standards for Bicycle Parking.

SECTION 8 – LANDSCAPE REQUIREMENTS FOR STORMWATER FACILITIES

8.1 INTRODUCTION

Successful revegetation is critical to the function of water quality and quantity facilities, and vegetated corridors. Plantings improve water quality and provide habitat and aesthetic benefits. The purpose of this Section is to assist design professionals in successfully planning, designing, and implementing landscape plans for water quality and quantity facilities and vegetated corridors. The information should not be used simply as a boilerplate applied to all sites. Instead, it should be used to guide design decisions to promote successful planting efforts. Each design will be unique and must consider the individual opportunities and constraints offered by each site.

8.2 LANDSCAPE GUIDELINES

The designer must consider four major components while developing landscape plans for water quality and quantity facilities: hydrology, soils, plant materials, and maintenance. Understanding the future hydrologic conditions at the treatment facility is critical to designing a successful planting plan. Identifying and correcting poor soil conditions and selecting and placing appropriate plant materials are also substantially important for planting success. Finally, landscape design and planting plans should not interfere with a facility's engineering function or create maintenance problems. These four components are discussed in detail below.

8.2.1 Hydrology

a. Varying hydrologic conditions complicate landscape design. Water levels change seasonally and also with local storm events. Treatment facilities are often inundated during the wet season and early growing season, but then dry out during the summer. These conditions must be understood and accounted for in the planting plan. Selected plants must be adapted to variable moisture regimes.
b. Landscape design and construction documents shall be prepared by a Landscape Architect registered in the State of Oregon are required. Construction documents detail the design and provide good control to assure the project is installed as designed. Proper installation provides predictable hydrologic conditions and thus increases the chances for successful planting

8.2.2 Soil

a. Plants require appropriate soil conditions to grow. On completion of earthwork, the landscape contractor is commonly left with soils that are high in clay or minerals and devoid of topsoil and organic material, or soils high in noxious weed content.
b. Site preparation is necessary to improve the soil and remove undesirable plant materials and seeds. Before planting, clearing and grubbing (see Subsection 2.5.2, "Clearing and Grubbing") may be required to remove rhizomes and seed banks where noxious weeds are present. Topsoil should be stripped and stockpiled for reuse whenever possible, but noxious weed conditions may require that topsoil is stripped and removed from the site.
c. Where topsoil has been removed, is not adequate, or does not exist, scarify the subgrade and import at least 4 inches of topsoil, unless noted otherwise. Imported topsoil should be tested for the following characteristics to assure it will provide a good growing medium for the selected plants:
    1. Texture – relative proportions of soil separates (sand, silt, and clay).

2. Fertility – nutrient content and fertility status of the soil.
3. Microbial – presence of microbial organisms in the soil.

d. Incorporate at least 2 inches of garden compost into imported topsoil. Where topsoil is present and is weed free, incorporate 2 inches of garden compost into the top 4 inches of the native soil. Incorporate other amendments, conditioners, and bio-amendments as needed to provide a soil capable of supporting the specified plants. Traditional fertilization techniques (applying N-P-K) are detrimental to the soil and should be avoided when using native plants.

8.2.3 Plant Materials

a. Plant selection must consider soil types, hydrologic conditions, and shade requirements. Dense planting with small stock is preferred to sparse planting with large stock. Native plant stock is recommended because many species are adapted to hydrologic conditions common in water treatment facilities and generally require minimal maintenance. Ornamental stock can be useful for blending treatment facilities into surrounding landscapes but is discouraged in areas that will not receive additional maintenance.
b. Plantings shall be installed between October 1 and November 15 or between February 1 and May 1. When plantings must be installed outside these times, additional measures may be needed to assure survival. Additional considerations for preparing planting plans include:
    1. Plant Massing: Plantings should be placed in-groups ranging from three to seven of the same species to encourage massing. Groupings may be larger, depending on the size of the facility. Groupings of different species can be placed next to each other, as long as the species are appropriate for the given hydrologic conditions.
    2. Plant quantities shall comply with the following minimum acceptable design standard:
        (a) Evergreen trees: 3 per 1000 square feet, minimum height 6 feet.
        (b) Deciduous trees: 2 per 1000 square feet, minimum caliper 1 to 1-1/2 inch at 2 feet above base.
        (c) Shrubs: 30 per 1000 square feet, minimum container 1 gallon or equivalent.
        (d) Wetland plants: 1 per 2 square feet of pond emergent plant zone.
    3. Planting Restrictions:
        (a) Do not place deep rooting trees and shrubs (e.g., willow) on top of pipe alignments.
        (b) Falling leaves will fill the pond and clog drainage structures. However, it is desirable to place trees, particularly evergreens, next to the south and west perimeter of standing water, to provide shade and thereby reduce water temperatures.
    4. Seeding: Seed mixes and application rates for wet, moist, and dry zones are provided in **Tables 8.4** and **8.5**. Alternative mixes may be approved by the City.
    5. Mulching: Trees, shrubs, and groundcovers shall be adequately mulched with an appropriate material (e.g., compost, bark dust) to retain moisture and discourage weed growth around newly installed plant material

8.2.4 Maintenance

Providing a low maintenance planting design should be a goal for every facility. However, all treatment facilities will require some degree of maintenance to help assure that facilities function as designed. Third parties (e.g., volunteer groups, homeowner associations) can provide additional maintenance if a more refined aesthetic is desired. The following maintenance issues should be addressed during project design and through the maintenance period:

a. Access: Access roads shall be provided as outlined in Subsection 3.4.4, “Access Road Design.”

b. Irrigation: A method for irrigation shall be installed and used during the plant establishment period, unless a natural water source is available and is an approved substitute by the City. Watering shall be provided to assure survival through the dry season.
c. Weed Control: The removal of noxious weeds including Himalayan blackberry (Rubus discolor), reed canary grass (Phalaris arundinacea), teasel (Dipsacus fullonum), Canada thistle (Cirsium arvense), and others will be necessary through the maintenance period, or until a healthy stand of desirable vegetation is established.
d. Plant Replacement: Plants that fail to meet the acceptance criteria must be replaced during the maintenance period (see Subsection 3.13.2, "Landscaping Inspection for Warranty"). Before replacing a plant, the cause for loss shall be determined. On determining the cause, correct the problem (e.g., amend soil, provide wildlife protection, modify species selection) and then replace the plant(s).
e. Erosion Control: Where seeding is used for erosion control, refer to Subsection 1.18.4, "Erosion Prevention and Sediment Control."
f. Wildlife Protection: Appropriate measures shall be taken to discourage wildlife browsing. Biodegradable plastic mesh tubing, or other substitute approved by the City, shall be placed around individual trees and shrubs to prevent browsing by wildlife, including beaver, nutria, deer, mice, and voles

8.3 RECOMMENDED PLANT SPECIES

a. This section outlines commonly available native plants suited for various hydrologic regimes and illustrates typical planting schemes for water quality and quantity facilities, and vegetated corridors. The schemes provide a foundation from which to begin planting design, but they may require modification in response to individual site characteristics. Consulting a professional landscape architect, ecologist, or horticulturist knowledgeable about native plants and water quality and quantity facility design is highly recommended when preparing planting plans.
b. Water quality facilities and vegetated corridors generally feature three types of planting zones with respect to hydrology during the growing season:
    1. Wet (standing or flowing water/nearly constant saturation; anaerobic soils).
    2. Moist (periodically saturated; anaerobic and/or aerobic soils).
    3. Dry (infrequent inundation/saturation, if any; aerobic soils).
    4. Open water, typically 3 feet or deeper, is also common in treatment facilities, particularly in fore bays and extended wet ponds. These areas are rarely vegetated, except by floating aquatics that generally volunteer on their own.
d. Specific plant sizes may be required as part of the development approval process but shall not be less than three to five-gallon container stock for trees; one-gallon container stock for shrubs; and conservation plugs for emergents. Live stakes shall be used for plantings. Live stakes may be used for other species that take readily from cuttings (e.g., Douglas spirea, red-osier dogwood). Conservation plugs are also known as leach tubes and styro-blocks. They typically have soil intact around deeply developed roots systems. They are the preferred alternative for most emergent stock. Rhizomes, tubers, bare root, and potted stock are also acceptable, but they may require additional planting quantities and higher densities to achieve design intent. Plant size and stock may be tailored to meet availability issues and the individual requirements of each site.

e. **Tables 8.1, 8.2,** and **8.3** list commonly available plants for wet, moist, and dry zones, respectively. The zones are used later in the planting schemes to depict different planting zones within the different water treatment facilities. Plants other than those listed in the following tables may be used with City approval.

Table 8.1. PLANTS FOR WET AREAS

Botanical Name	Common Name	Spacing	Preferred Light	Comments
Trees				
Salix sp.	Willow species	3-5’ O.C.	Sun, part shade	
Shrubs				
Cornus sericea	Red-osier dogwood	3-4’ O.C.	Sun, part shade	Highly adaptable
Spirea douglasii	Douglas spirea	2-3’ O.C.	Sun	Tolerates prolonged inundation
Herbaceous				
Alisma plantago-aquatica	Water plantain			
Beckmannia syzigachne	American slough grass			
Bidens cernua	Nodding beggar’s tick	1-2’ O.C.	Sun	
Bromus carinatus	California brome grass			
Carex densa	Dense sedge	12” O.C.	Sun	
Carex comosa	Bearded sedge	12” O.C.	Sun	Tolerates variable water regimes
Carex obnupta	Slough sedge	12” O.C.	Shade or part shade; will tolerate sun	Tolerates variable water regimes
Carex stipata	Sawbeak sedge	12” O.C.	Part shade	
Deschampsia caespitosa	Tufted hairgrass			
Deschampia caespitosa	Tufted hairgrass			
Elecoharis spp.	Spikerushes	12” O.C.	Sun	Tolerate prolonged inundation
Elymus glaucus	Blue wildrye			
Festuca rubra v. rubra	Native red fescue			
Iris tenax	Oregon iris			
Juncus effuses	Soft rush			
Juncus ensifolius	Daggerleaf rush	12” O.C.	Sun	
Juncus acuminatus	Tapertip rush	12” O.C.	Sun	
Juncus oxymeris	Pointed rush	12” O.C.	Sun	
Lysichitum americanum	Skunk cabbage			
Sagittaria laifolia	Wapato	12” O.C.	Sun	Favors prolonged inundation (to 6”)
Scirpus acutus	Hardstem bulrush	18-24” O.C.	Sun	Favors prolonged inundation
Scirpus microcarpus	Small-fruited bulrush	12” O.C.	Sun, part shade	Tolerates prolonged inundation (to 6”)
Scirpus tabernaemontanii	Softstem bulrush	18-24” O.C.	Sun	Favors prolonged inundation
Sparganium emersum	Simplestem bur reed	12-18” O.C.	Sun, part shade	
Aquatics				
Nuphar luteum ssp.	Pond lily	3’ O.C.	Sun	

Table 8.2. PLANTS FOR MOIST AREAS

Botanical Name	Common Name	Spacing	Preferred Light	Comments
Trees				
Alnus rubra	Red alder	6-10’ O.C.	Sun	Highly adaptable; nitrogen fixer
Acer macrophyllum	Big leaf maple	12-18’ O.C.	Sun	
Cornus stolonifera	Redtwig dogwood			
Crataegus douglasii	Black hawthorn	6-10’ O.C.	Sun	
Fraxinus latifolia	Oregon ash	10-15’ O.C.	Sun, part shade	
Thuja plicata	Western red cedar	12-18’ O.C.	Park shade, shade	
Shrubs				
Acer circinatum	Vine maple	10 O.C.	Part sun, shade	
Lonicera involucrata	Twinberry	5’ O.C.	Part shade	
Oemleria ceraisformis	Indian plum	5-8’ O.C.	Shade	Tolerates fluctuating water table
Physocarpus capitatus	Pacific ninebark	5-8’ O.C.	Part shade	
Rosa nutkana	Nootka rose	5’ O.C.	Sun	
Rosa pisocarpa	Swamp rose	5’ O.C.	Part shade	
Rubus spectabilis	Salmonberry	5’ O.C.	Sun, part shade	Prefers slightly drier soils
Sambucus racemosa	Red elderberry	5-8’ O.C.	Part shade	
Symphoricarpos albus	Snowberry	5’ O.C.	Sun, shade	Prefers well drained soils
Herbaceous				
Aster chilensis ssp. Hallii	Common California aster	3’ O.C.	Sun	
Aster subspicatus	Douglas’s aster	3’ O.C.	Sun	
Cammasia quamash ssp.	Common camas	12” O.C.	Part shade	Bulb; prefers drier soil
Carex aperta	Columbia sedge	12” O.C.	Sun	
Carex deweyana	Dewey’s sedge	12” O.C.	Sun, part shade	
Carex obnupta	Slough sedge	12” O.C.	Part shade	
Carex stipata	Sawbeak sedge	12” O.C.	Part shade	
Gualtheria shallon	Salal	3-4’ O.C.	Part shade, shade	Prefers moist, well-drained soils
Juncus tenuis	Slender rush	12” O.C.	Sun	
Juncus patens	Spreading rush	1-2’ O.C.	Sun Part shade	
Polystichum munitum	Sword fern	3-4’ O.C.	Part sun, shade	Prefers moist, well drained soils
Scirpus microcarpus	Small-fruited bulrush	12” O.C.	Sun, part shade	Prefers moister soils

Table 8.3. PLANTS FOR DRY AREAS

Botanical Name	Common Name	Spacing	Preferred Light	Comments
Trees				
Alnus rubra	Red alder	6-10’ O.C.	Sun	Highly adaptable; nitrogen fixer
Corylus cornuta	Hazelnut	6-10’ O.C.	Sun	
Prunus emarginata	Bitter cherry	6-10’ O.C.	Sun	Shade intolerant
Quercus garryana	Oregon white oak	10-15’ O.C.	Sun	
Pseudotsuga menziesii	Douglas fir	10-15’ O.C.	Sunm, part shade	
Shrubs				
Amelanchier alnifolia	Western serviceberry	5’ O.C.	Sun, part shade	
Holodiscus discolor	Oceanspray	9’ O.C.	Sun, part shade	
Ribes sanguineum	Red flowering currant	6’ O.C.	Sun, part shade	
Rosa gymnocarpa	Baldip rose	6’ O.C.	Sun	
Rubus parviflorus	Thimbleberry	5’ O.C.	Part shade	
Sambucus racemosa	Red elderberry	5’ O.C.	Part shade	
Symphoricarpos albus	Snowberry	5’ O.C.	Sun/shade	
Herbaceous				
Achillea millefolium	Western yarrow		Sun	1 lb/acre
Arctostaphylos uva-ursi	Kinnikinnick	12-18” O.C.	Sun/shade	
Bromus carinatus	Native California brome		Sun	10 lb/acre
Elymus glaucus	Blue wildrye		Sun	9 lb/acre
Festuca rubra v. rubra	Native red fescue			
Fragaria vesca	Wood strawberry	1’ O.C.	Part shade	
Gualtheria shallon	Salal	3-4’ O.C.	Part shade Shade	Prefers moist, well-drained soils
Lupinus bicolor	Two-color lupine		Sun	8 lb/acre
Lupinus latifolius	Broadleaf lupine		Sun	8 lb/acre
Lupinus polyphylus	Large-leafed lupine		Sun	8 lb/acre
Mahonia aquifolium	Tall Oregon grape	4-6’ O.C.	Sun, part shade	
Mahonia nervosa	Cascade Oregon grape	3-4’ O.C.		
Mahonia repens	Creeping Oregon grape	2-3’ O.C.		
Solidago canadensis	Canada goldenrod		Sun	2 lb/acre

8.4 SEED MIXES

The seed mixes indicated in **Tables 8.4** and **8.5** shall be used to overseed in water quality and quantity facilities, and vegetated corridors. One seed mix is prescribed for use in wet and moist zones, and one for dry zones. Alternative mixes may be approved by the City. Broadcast application is discouraged to prevent wind drift of the smaller, native seeds. Lower rates may be used in areas where seeding is intended to augment other plantings (e.g. the bottom of water quality swales).

Table 8.4. WET/MOIST AREA SEED MIX

Scientific Name	Common Name	% Mixture
Elymus glaucus	Blue Wildrye	47
Hordeum brachyantherum	Meadow Barley	40
Deschampsia caespitosa	Tufted Hairgrass	10
Glyceria occidentalis	Western Mannagrass	2
Beckmannia syzigachne	American Sloughgrass	1

*Pro Time 840 Native Wetland Mix. Application rate: 87 lbs./acre (minimum)

Table 8.5. DRY AREA SEED MIX

Scientific Name	Common Name	% Mixture
Elymus glaucus	Blue Wildrye	60
Hordeum brachyantherum	Meadow Barley	30
Bromus carinatus	Native California Brome	10

*Pro Time 400 Native Grass Mix. Application rate: 30 lbs./acre (minimum)

8.5 PLANTING SCHEMES

The following schemes provide general recommendations for plant placement in water quality facilities and buffers. These are guidelines only; planting plans must be individually tailored to unique conditions at each site.

8.5.1 Water Quality Swale

Water quality swales should generally be vegetated with emergents in the swale bottom, with emergents, groundcovers, and shrubs on the side slopes, and with groundcovers, shrubs, and trees on the adjacent dry areas. Typically, the swale bottom is wet, the lower 8 to 12 inches of the side slopes are moist, and areas 12 inches above the bottom of the swale are dry.

8.5.2 Extended Dry/Wet Pond

Extended dry ponds and extended wet ponds should be vegetated similarly to water quality swales. Emergents should be placed in the pond bottom, emergents, groundcovers, and shrubs on the side slopes, and groundcovers, shrubs, and trees on the adjacent dry areas. The hydrologic planting zones will vary in the facilities, but typically, wet areas occur at or below the permanent pool elevation, moist areas occur between the permanent pool elevation and maximum pool elevation, and dry areas occur above the maximum pool elevation.

8.5.2 Constructed Wetland

Constructed wetlands should feature dense emergent plantings in the wet zones, which are typically composed of deep and shallow emergent areas. Floating aquatics and emergents capable of surviving extended or permanent inundation may also be placed in the permanent pool areas. The moist zones should be planted with emergents, groundcovers, shrubs, and trees, and the dry zones with groundcovers, shrubs, and trees.

8.5.3 Vegetated Corridors

Three types of vegetated corridors are described below: headwater forests, riparian forests, and forested wetlands. Upland and wetland habitats are present in all three types; local topography and drainage patterns dictate where the habitats occur.

a. Headwater Forest: Headwater forests are densely wooded and wet throughout most of the year. Steep valley slopes prone to landslides drain the top of the watershed to the stream below. Perennial to intermittent flows may occur, depending on local conditions. Channels range from shallow to deeply entrenched, with rock and large woody debris common throughout. A mixture of wetland and upland species may occur in this community, depending on local drainage and topography. The headwater forest should be planted with 200 trees per acre (three species min.), 300 shrubs per acre (four species min.), and 1,000 emergents per acre (two species min.).
b. Riparian Forest: Riparian forests are moderately to densely wooded floodplains beside a stream. Landscape character ranges from flat with open floodplain to moderately steep with U-shaped valleys and upland terraces. They are frequently inundated during the rainy season and moist to dry during the summer. Hydrologic conditions vary. Channels with large woody debris are typically moderately to deeply incise with flat floodplains. Wetland species are the norm, but upland species do occur where microtopography allows. The riparian forest should be planted with 170 trees per acre (two species min.), 300 shrubs per acre (four species min.), and 2,000 emergents per acre (three species min.).
c. Forested Wetland: Forested wetlands are densely wooded, wet in the winter, and frequently dry out in the summer. The landscape is flat to gently rolling and may be perched above the stream in some areas. Frequently flooded with low-velocity overbank flows or rainwater results in shallow groundwater interaction or surface water influence into June in normal rainfall years. Stream channels range from shallow to deeply entrenched, depending on local conditions. A natural levee is common along the stream. The forested wetland should be planted with 200 trees per acre (two species min.), 300 shrubs per acre (three species min.), and 4,000 emergents per acre (three species min.).

SECTION 9 – INFILTRATION REQUIREMENTS, SITE CHARACTERIZATION, AND SITE SUITABILITY CRITERIA

9.1 INTRODUCTION

This Section specifies the site characterization and site suitability criteria that must be considered for siting infiltration treatment facilities. For infiltration treatment facilities site selection and design decisions, a geotechnical and hydrogeologic report shall be prepared by a qualified engineer with geotechnical and hydrogeologic experience. A comparable professional, acceptable to the City, may also conduct the work if it is under the seal of a Professional Engineer registered in the State of Oregon. The design engineer shall utilize a team of certified or registered professionals in soil science, hydrogeology, geology, and other related fields. A member of this design team shall be considered/designated the site professional (as referenced in this Section 9).

9.2 SITE CHARACTERIZATION

Applicant shall conduct a site characterization study prior to siting and designing infiltration treatment facilities. Information gathered during initial geotechnical investigations shall be used for the site characterization. Key data and issues to be characterized include, but are not limited to, the following.

9.2.1 Surface Feature Characterization

a. Topography within 500 feet of the proposed facility. The plan shall show existing ground contours (shaded) and proposed ground contours at a minimum 2-foot contour interval. Slopes steeper than 6H:1V shall be identified.
b. Anticipated site use (residential, commercial, or industrial).
c. Location of water supply wells within 500 feet of proposed facility.
d. Location of ground water protection areas and/or 1-, 5-, and 10-year time of travel zones for municipal well protection areas.
e. A description of local site geology, including soil or rock units likely to be encountered, the groundwater regime, and geologic history of the site.
f. Site location relative to identified flood plain or floodway.
g. Site location relative to surface water features, such as waterways, wetlands, etc.

9.2.2 Subsurface Characterization

a. Subsurface explorations (test holes or test pits) shall be performed to a depth of at least five times the maximum design depth of ponded water proposed for the infiltration treatment facility.
b. Continuous sampling (representative samples from each soil type and/or unit) to a depth below the base of the infiltration facility of 2.5 times the maximum design ponded water depth, but not less than 6 feet.
    1. For basins, at least one test pit or test hole per 5,000 square feet of basin infiltrating surface (in no case less than two per basin).
    2. For trenches, at least one test pit or test hole per 50 feet of trench length (in no case less than two per trench).
c. Prepare detailed logs for each test pit or test hole and a map showing the location of the test pits or test holes. Logs must include at a minimum, depth of pit or hole, soil descriptions, depth to water, presence of stratification.

9.2.3 Soil Testing

Soil characterization for each soil unit (soils of the same texture, color, density, compaction, consolidation and permeability) encountered should include:

a. Grain-size distribution (ASTM D-422 or AASHTO T-311).
b. Textural class (USDA).
c. Percent clay content (include type of clay, if known) as determined by hydrometer testing (ASTM D-422 or AASHTO T-88).
d. Cation exchange capacity (CEC) and organic matter content for each soil type and strata. Where distinct changes in soil properties occur, to a depth below the base of the infiltration treatment facility of at least 2.5 times the maximum design water depth, but not less than 6 feet. Consider if soils are already contaminated, thus diminishing pollutant sorptive capacity.
e. For soils with low CEC and organic content, deeper characterization of soils may be required by the City (refer to Subsection 9.3, "Site Suitability Criteria").
f. Color/mottling.
g. Variations and nature of stratification.

9.2.4 Infiltration Rate Determination

a. Determine the representative infiltration rate of the unsaturated vadose zone based on field infiltration tests and grain size/texture determinations. Field infiltration rates shall be determined using infiltration test methods as presented in the King County Surface Water Design Manual or comparable reference; infiltration testing shall be done in the soil stratum at the design elevation of the bottom of the infiltration facility.
b. Site testing shall be performed to verify infiltration rate estimates based on soil size distribution and/or texture. As a minimum, one soil grain-size distribution analysis (ASTM D-422 or AASHTO T-311) per soil stratum in each test hole shall be performed within 2.5 times of the maximum design water depth, but not less than 6 feet.
c. The infiltration rate is needed for routing and sizing purposes and for classifying the soil for treatment adequacy.

9.2.5 Infiltration Receptor

Infiltration receptor (unsaturated and saturated soil receiving the stormwater) characterization shall include:

a. Installation of ground water monitoring wells, unless the highest ground water level is known to be at least 50 feet below the proposed infiltration facility. Use at least three wells per infiltration treatment facility, or three hydraulically connected surface and ground water features. This will establish a three-dimensional relationship for the ground water table. The monitoring wells will:
    1. Monitor the seasonal ground water levels at site through a minimum of one wet-season.
    2. Consider the potential for unconfined and confined aquifers, or confining units, at the site that may influence the proposed infiltration facility as well as the ground water gradient. Other approaches to determine ground water levels at the proposed site could be considered if pre-approved by the Public Works Director or the Public Works Department authorized representative.
    3. Determine the ambient ground water quality, if there is a concern identified by the City.
b. Estimate the volumetric water holding capacity of the infiltration receptor soil. This is the soil layer below the infiltration treatment facility and above the seasonal high-water mark, bedrock, hardpan, or other low permeability layer. This analysis should be conducted at a conservatively high infiltration rate based on vadose zone porosity, and the water quality

runoff volume to be infiltrated. Along with an analysis of ground water movement, this will be used in determining volumetric limitations that would adversely affect drawdown.

c. Depth to ground water table and to bedrock/impermeable layers.
d. Seasonal variation of ground water table based on recorded well water levels and observed mottling.
e. Existing ground water flow direction and gradient.
f. Lateral extent of infiltration receptor.
g. Horizontal hydraulic conductivity of the saturated zone to assess the aquifer's ability to laterally transport the infiltrated water.
h. Impact of the infiltration rate and volume at the project site on ground water mounding, flow direction, and water table; and the discharge point or area of the infiltrating water. A ground water mounding analysis shall be conducted at all sites where the depth to seasonal ground water table or low permeability stratum is less than 15 feet and the runoff to the infiltration treatment facility is from more than one acre. The site professional can consider conducting an aquifer test or slug test and the type of ground water mounding analysis necessary at the site.

9.3 SITE SUITABILITY CRITERIA

This section specifies the site suitability criteria that must be considered for siting infiltration treatment facilities. When a site investigation reveals that any of the nine applicable criteria cannot be met, appropriate mitigation measures must be implemented so that the infiltration treatment facility will not pose a threat to safety, health, and the environment.

9.3.1 Setbacks

Setback requirements shall follow City regulations, uniform building code requirements, and/or state regulations. Also evaluate on-site and off-site structural stability due to extended subgrade saturation and/or head loading of the permeable layer, including the potential impacts to down-gradient properties, especially on hills with known side-hill seeps.
The following setbacks are provided as guidance.

a. From drinking water wells, septic tanks or drain fields, and springs used for public drinking water supplies. Infiltration treatment facilities up-gradient of drinking water supplies and within 1, 5 and 10-year time of travel zones must comply with Oregon Health Division requirements.
b. From building foundations (a minimum of 20 feet down-slope and 100 feet upslope).
c. From the top of slopes steeper than 10% (setback a minimum of 50 feet from crest of slope).

9.3.2 Ground Water Drinking Water Protection Areas

A site shall be deemed not suitable if the infiltrated stormwater will be in violation of OAR 340-044-0014.

9.3.3 High Vehicle Traffic Areas

Infiltration treatment facilities may be considered for runoff from areas of industrial activity and the high vehicle traffic areas described below, if appropriate pretreatment (including oil removal) is provided to ensure that ground water quality standards will not be violated and that the infiltration treatment facility will not be adversely affected.
High Vehicle Traffic Areas are defined as:

a. Commercial or industrial sites subject to an expected ADT $\geq$ 100 vehicles/1,000 square feet gross building (trip generation); and
b. Road intersections with an ADT of $\geq$ 25,000 on the main roadway, or $\geq$ 15,000 on any intersecting roadway.

9.3.4 Soil Infiltration Rate/Drawdown Time

a. Infiltration rates short-term and long-term:
    1. For treatment purposes the short-term soil infiltration rate should be 2.4 inch/hour, or less, to a depth of 2.5 times the maximum design pond water depth, or a minimum of 6 feet below the base of the infiltration treatment facility. This infiltration rate is also typical for soil textures that possess sufficient physical and chemical properties for adequate treatment, particularly for soluble pollutant removal (see Subsection 9.3.6, "Soil Physical and Chemical Suitability for Treatment"). It is comparable to the textures represented by Hydrologic Groups B and C. Long-term infiltration rates up to 2.0 inches/hour can also be considered, if the infiltration receptor is not a sole-source aquifer, and in the judgment of the site professional, the treatment soil has characteristics comparable to those specified in criteria #6 to adequately control the target pollutants.
    2. The long-term infiltration rate should also be used for maximum drawdown time and routing calculations.

b. Drawdown time:
    It is necessary to empty the maximum ponded depth (water quality volume) from the infiltration basin within 24 hours from the completion of inflow to the storage pond in order to meet the following objectives:
    1. Restore hydraulic capacity to receive runoff from a new storm.
    2. Maintain infiltration rates.
    3. Aerate vegetation and soil to keep the vegetation healthy.
    4. Enhance the biodegradation of pollutants and organics in the soil.

9.3.5 Depth to bedrock, Water Table, or Impermeable Layer

The base of all infiltration basins or trench systems shall be $\geq$ 5 feet above the seasonal high-water mark, bedrock (or hardpan) or other low permeability layer. A minimum separation of 3 feet may be considered if the ground water mounding analysis, volumetric receptor capacity, and the design of the overflow and/or bypass structures are judged by the site professional to be adequate to prevent overtopping and to meet the site suitability criteria specified in this section.

9.3.6 Soil Physical and Chemical Suitability for Treatment

The soil texture and design infiltration rates should be considered along with the physical and chemical characteristics specified below to determine if the soil is adequate for removing the target pollutants. The following soil properties must be carefully considered in making such a determination:

a. CEC of the treatment soil must be $\geq$ 5 millequivalents (meq) CEC/100 g dry soil (USEPA Method 9081). Consider empirical testing of soil sorption capacity, if practicable. Ensure that soil CEC is sufficient for expected pollutant loadings, particularly heavy metals. Lower CEC content may be considered if it is based on a soil loading capacity determination for the target pollutants that is accepted by the Public Works Director or the Public Works Department authorized representative.
b. Depth of soil used for infiltration treatment must be a minimum of 18 inches.
c. Organic content of the treatment soil as determined by ASTM D-2974: Organic matter can increase the sorptive capacity of the soil for some pollutants. The site professional should evaluate whether the organic matter content is sufficient for control of the target pollutant(s).

d. Waste fill materials should not be used as infiltration media nor should such media be placed over uncontrolled or non-engineered fill soils.
e. Engineered soils may be used to meet the design criteria in this section. Field performance evaluation(s), using acceptable protocols, would be needed to determine feasibility, and acceptability by the Public Works Director or the Public Works Department authorized representative.

9.3.7 Seepage Analysis and Control

Determine whether there would be any adverse effects caused by seepage zones on nearby building foundations, basements, roads, parking lots or sloping sites.

9.3.8 Impact of Roadway Deicers

Potential impact of roadway deicers on potable water wells must be considered in the siting determination. Mitigation measures must be implemented if infiltration of roadway deicers can cause a violation of ground water quality standards.

9.3.9 Verification Testing of the Completed Facility

Verification testing of the completed full-scale infiltration treatment facility is recommended to confirm that the design infiltration parameters are adequate to manage the design volume and meet the pollutant capture objectives of the infiltrating soil. The site professional should determine the duration and frequency of the verification testing program for the potentially impacted ground water. The ground water monitoring wells installed during site characterization may be used for this purpose. Long-term in-situ drawdown and water quality monitoring for a two-year period, would be preferable.

SECTION 10 – STORMWATER QUALITY FACILITY DESIGN

10.1 INTRODUCTION

The purpose of this Section is to outline the design and construction guidelines for water quality facilities in the City of Molalla. These guidelines may be used to comply with the water quality facility design standards in Subsection 3.5, "Water Quality Facility Design." It is the responsibility of the design engineer to determine the appropriate design criteria that ensures compliance with the City of Molalla design standards, in combination with other federal, state, and local laws and ordinances. Safety of stormwater quality facilities shall be in conformance with "Safety" in Subsection 3.3.9, "Detention/Retention Facility Protection."

10.2 FILTRATION

10.2.1 Biofiltration Swale

a. Hydraulic design criteria
    1. Design storm = water quality storm
    2. Minimum hydraulic residence time = 9 minutes.
    3. Maximum water design depth = 0.5 feet.
    4. Minimum freeboard = 1.0 foot (for facilities not protected from high flows).
    5. Manning *n* value = 0.24.
    6. Maximum velocity = 2.0 feet per second based on 25-year flow.
b. Design criteria
    1. Provide an energy dissipater at the entrance to the swale as per Subsection 3.3.7, "Channel Protection." It shall be designed to reduce velocities and spread the flow across the treatment cross-section.
    2. Intermediate flow spreaders may be required.
    3. Minimum length = 100 feet.
    4. Minimum slope = 0.5%.
    5. Minimum bottom width = 2 feet.
    6. Maximum treatment depth (measured from top of gravel) = 0.5 feet.
    7. Maximum side slope:
        (1) In treatment area = 4H:IV
        (2) Above treatment area = 3H:IV
    8. Use 2"-¾" gap-graded river aggregate placed 2½ to 3 inches deep on jute matting placed over 6 inches of topsoil or use another base-stabilization method approved by the Public Works Department authorized representative. Extend river aggregate, jute, and topsoil to top of treatment area.
    9. If the swale slope is less than 1.5%, an underdrain shall be installed using a perforated pipe, or equivalent. Amend the soil if necessary, to allow effective percolation of water to the underdrain. Underdrains can be made of 6-inch diameter Schedule 40 PVC perforated pipe with 6 inches of drain gravel over the pipe. The gravel and pipe must be enclosed by geotextile fabric. Slopes greater than 2.5% need check dams (riprap) at vertical drops of 12-15 inches.
    10. Retaining walls are not allowed in the treatment area.
    11. Provide an approved outlet structure for all flows.
    12. All exposed areas shall be protected with jute matting or an alternative approved by the Public Works Department authorized representative.

13. Plant vegetation consistent with the requirements of Section 8, "Landscape Requirements for Stormwater Facilities."

10.2.2 Sand Filter

a. Design Criteria
   1. The design of sand filters is based on Darcy's Law (Safety Factor = 2):
      $A = Q \div (k \times i)$
      Where: A = area of sand filter.
      Q = peak flow rate (from hydrograph).
      k = sand permeability (3.5 feet/day).
      i = hydraulic gradient (see below).
      $I = (h + L) \div L$
      Where: h = height of water column over sand filter.
      L = thickness of sand filter.
   2. No drainage shall be allowed directly to the filter; it must first go through a catch basin, inlet, sedimentation manhole, or similar large debris collection device.
   3. The sand filter shall infiltrate the entire water quality volume without overflow.
   4. The drawdown period for sand filters shall not exceed 24 hours.
   5. The sand filter shall consist of an inlet structure, a sand bed, underdrain piping, and a basin liner. Criteria for these components are given below.

b. Inlet Structure
   The inlet structure shall spread the flow of incoming water uniformly across the surface of the filter medium during all anticipated flow conditions. At a minimum, the inflow spreader shall meet the requirements as provided in Subsection 3.3.8, "Outfall Protection". It shall be designed to reduce velocities and spread the flow across the treatment cross-section. Flow shall be spread in a manner that prevents roiling or otherwise disturbing the filter medium.

c. Sand Bed—Filter Medium
   1. The length-to-width ratio shall be 2:1 or greater.
   2. The filter bed medium shall consist of clean, medium to fine sand, with no organics, frozen pieces, or other deleterious materials. Sand used as a filter medium shall be certified by a certified testing laboratory as meeting or exceeding the gradation requirements in **Table 10.1**. Sieve analysis shall be determined according to AASHTO T-27.

Table 10.1. GRADATION REQUIREMENTS FOR FILTER BED MEDIUM

Sieve Size	Percent Passing
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	45-85
No. 30	15-60
No. 50	3-15
No. 100	< 4

d. Sand Bed with Gravel Filter
   1. The top layer shall be a minimum of 18 inches of sand meeting gradation requirements of **Table 10.1**.
   2. The sand shall be placed over a non-woven geotextile fabric material, meeting the specifications provided in **Table 10.2**, covering a layer of ½- to 2-inch washed drain rock. The finished depth of this drain rock shall be sufficient to provide a minimum of 2 inches of cover over the underdrain piping system.
   3. No gravel is required below the underdrain piping system.

Table 10.2. GEOTEXTILE FABRIC MATERIAL SPECIFICATIONS

Property	Test Method	Specification
Unit Weight	--	8 oz./SY (minimum)
Filtration Rate	--	0.08 inch/sec (minimum)
Puncture Strength	ASTM D-751 (modified)	125 lb (minimum)
Mullen Burst Strength	ASTM D-751	400 psi (minimum)
Tensile Strength	ASTM D-1682	200 lb (minimum)
Equivalent Opening Size	US Standard Sieve	80-120

e. Sand Bed Using Trench Design
   1. The top layer shall be a minimum of 12 inches of sand meeting gradation requirements of **Table 10.1**.
   2. The sand shall be placed over a non-woven geotextile fabric material, meeting the specifications provided in **Table 10.2**, covering a layer of ½- to 2-inch washed drain rock. The finished depth of this drain rock shall be sufficient to provide a minimum of 2 inches of cover over the underdrain piping system.
   3. The piping and gravel shall be underlain with drainage matting meeting the specifications provided in **Table 10.3**.

Table 10.3. DRAINAGE MATTING MATERIAL SPECIFICATIONS

Property	Test Method	Specification
Unit Weight		20 oz./SY
Flow Rate (fabric)		180 gpm/SF (minimum)
Permeability	ASTM D-2434	0.124 cm/sec
Grab Strength (fabric)	ASTM D-1682	Dry Lg 90 Dry Wd 70 Wet Lg 95 Wet Wd 70
Puncture Strength (fabric)	COE CW-02215	42 (minimum)
Mullen Burst Strength	ASTM D-117	140 psi (minimum)
Equivalent Opening Size	US Standard Sieve	80 – 120
Flow Rate (drainage core)	Drexel Universal Test Method	14 gpm/ft. width

f. Underdrain Piping
   1. The underdrain piping system shall consist of appropriately sized perforated pipes (minimum 4-inch diameter). The pipe used in this system shall be schedule 40 polyvinyl chloride (PVC) material, or an approved equal. Flexible perforated pipe will not be approved. Lateral spacing shall not exceed 10 feet.
   2. The underdrain laterals shall be placed with positive gravity drainage to the collector pipe
   3. The collector pipe shall have a minimum 1% grade toward the discharge point.
   4. All laterals and collector pipe shall have cleanouts installed, accessible from the surface without removing or disturbing filter media.

g. Basin Liner
   1. An impermeable liner is required for all sand filter systems. The liner shall comply with the requirements provided in Section 11, "Stormwater Quality Facility Liners."
   2. Geomembrane liners shall meet the requirements provided in Subsection 11.4.3, "Geomembrane Liners." They shall be placed on a smooth, compacted bed of sand, minimum 6 inches thick, graded as necessary to facilitate the hydraulic performance designed into the facility.

10.3 PONDS

10.3.1 Wet Ponds

a. Hydraulic design criteria
   1. Permanent pool volume = 0.55 × WQV (Water Quality Volume).
   2. Minimum water quality detention/retention volume = 1.0 × WQV.
   3. Water quality drawdown time = 48 hours.
   4. To calculate orifice size, use the following equation:

      $D = 24 \times [(Q / (\pi C_d[2gH]^{0.5})]^{0.5}$

      Where: D = orifice diameter (inches).

      Q (cfs) = WQV (cf)/(48 hr. × 60 min/hr. × 60 sec/min).

      C_d = orifice coefficient (0.62 for square-edged entrance).

g = gravitational constant (32.2 ft./sec^2).

H = ⅔ temporary detention height (feet) to orifice centerline.

5. Maximum depth of permanent pool = 6 feet
6. Maximum depth of water quality pool (not including permanent pool) = 2.5 feet.
7. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and shall be armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.
8. Provide for a basin dewatering system with a 24-hour maximum drawdown time.

b. Design Criteria

1. The pond configuration, as well as the inlet and outlet locations, shall maximize water travel time through the facility.
2. The pond shall be designed using the following surface-area-to-depth relationship (for the volume required by a permanent pool):

   70% of the surface area @ 2- to 6-foot depth

   30% of the surface area @ 0- to 2-foot depth

   The maximum depth of the permanent pool shall be 6 feet. The 0-to-2-foot depth shall be distributed evenly around the perimeter of the pond.
3. The facility shall be divided into at least two cells. The first cell (forebay) shall contain approximately 10% of the design surface area.
4. The construction of wets ponds and maintenance accessibility shall be in conformance with Subsection 3.2.3, “Design Criteria,” Subsection 3.3.9, “Detention/Retention Facility Protection,” and Subsection 3.4.4, “Access Road Design.”
5. Safety of stormwater quality facilities shall be in conformance with “Safety” in Subsection 3.3.9, “Detention/Retention Facility Protection.”
6. The slopes in the treatment and surrounding areas of the pond shall be 3H:1V or flatter, unless approved by the Public Works Department authorized representative. If steeper slopes are desired, the site shall be fenced as described in Subsection 3.3.9, “Detention/Retention Facility Protection.” The applicant shall provide calculations and geotechnical data indicating adequate slope stability. Calculations and data shall be provided from a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering.
7. The average length-to-width ratio shall be at least 3:1. This ratio is critical to prevent “short-circuiting,” where water passes directly through the facility without being detained for any time.
8. If a riser pipe outlet is used, it shall be protected by a trash rack and anti-vortex plate. If an orifice plate is used, it shall be protected with a trash rack with at least 10 square feet of open surface area. In either case, the rack must be hinged or easily removable to allow for cleaning. The rack shall be adequately secured to prevent it from being removed or opened when maintenance is not in progress.

c. Dead Storage
    1. The dead (permanent) storage volume, V_{pond}, is equivalent to the post-development runoff.
    2. Calculating runoff volume using the SBUH method can be approximated by the following equation:

        $V = 25.9 \times A \times \% I + 27.7 \times A$

        Where: V = runoff volume (cubic feet).
        A = total contributing land area (acres).
        % I = percent of land area that is impervious.
        (i.e., if the land is 20% impervious, enter 20 in the equation).

10.3.2 Extended Wet Ponds

a. Hydraulic design criteria
    1. Permanent pool volume = 0.55 × WQV.
    2. Minimum water quality detention/retention volume = 1.0 × WQV.
    3. Water quality drawdown time = 48 hours.
    4. To calculate orifice size, use the following equation:

        $D = 24 \times [(Q / (\pi C_d[2gH]^{0.5})]^{0.5}$

        Where: D = orifice diameter (inches).
        Q (cfs) = WQV (cf)/(48 hr. × 60 min/hr. × 60 sec/min).
        C_d = orifice coefficient (0.62 for square-edged entrance).
        g = gravitational constant (32.2 ft./sec^2).
        H = ⅔ temporary detention height (feet) to orifice centerline.
    5. Maximum depth of permanent pool = 2 feet.
    6. Maximum depth of water quality pool (not including permanent pool) = 2.5 feet.
    7. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and shall be armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.
    8. Provide for a basin dewatering system with a 24-hour maximum drawdown time.
b. Design criteria
    1. Minimum of two cells, with the first cell (forebay) at least 10% of the design surface area. The forebay shall also constitute 20% of the treatment volume. Where space limits multi-cell design, use one cell with a forebay at the inlet to settle sediments and distribute flow across the wet pond.
    2. Maximum side slopes in basin treatment area = 3H:IV
    3. Over excavate by a minimum of 20% to allow for sediment deposition.
    4. Minimum freeboard = 1 foot from 25-year design water surface elevation.
    5. Retaining walls are not allowed in the treatment area.
    6. Provide an approved outlet structure for all flows.
    7. The construction of wet ponds and maintenance accessibility shall be in conformance with Subsection 3.2.3, “Design Criteria,” Subsection 3.3.9, “Detention/Retention Facility Protection,” and Subsection 3.4.4, “Access Road Design.”

10.3.3 Extended Dry Pond

a. Hydraulic design criteria
    1. Permanent pool depth = 0.4 feet.
    2. Permanent pool is to cover the entire bottom of the basin.
    3. Minimum water quality detention/retention volume = 1.0 × WQV.

4. Water quality drawdown time = 48 hours.
5. To calculate orifice size, use the following equation:

   $D = 24 \times [(Q / (\pi C_d[2gH]^{0.5})]^{0.5}$

   Where: D = orifice diameter (inches).

   Q (cfs) = WQV (cf)/(48 hr. × 60 min/hr. × 60 sec/min).

   C_d = orifice coefficient (0.62 for square-edged entrance).

   g = gravitational constant (32.2 ft./sec^2).

   H = ⅔ temporary detention height (feet) to orifice centerline.
6. Maximum depth of water quality pool (not including permanent pool) = 4 feet.
7. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.

b. Design criteria
1. Minimum of two cells, with the first cell (forebay) at least 10% of the design surface area. The forebay shall also constitute 20% of the treatment volume. Where space limits multi-cell design, use one cell with a forebay at the inlet to settle sediments and distribute flow across the wet pond.
2. Minimum bottom width = 4 feet
3. Maximum side slope in basin treatment area = 4H:IV.
4. Minimum freeboard = 1 foot from 25-year design water surface elevation.
5. Retaining walls are not allowed in the treatment area.
6. An approved outlet structure shall be provided for all flows.
7. The construction of dry ponds and maintenance accessibility shall be in conformance with Subsection 3.2.3, "Design Criteria," Subsection 3.3.9, "Detention/Retention Facility Protection," and Subsection 3.4.4, "Access Road Design."

10.4 WETLANDS

b. Hydraulic design criteria
1. Permanent pool volume = 0.55 × WQV.
2. Water quality detention/retention volume = 1.0 × WQV.
3. Water quality drawdown time = 48 hours.
4. To calculate orifice size, use the following equation:

   $D = 24 \times [(Q / (\pi C_d[2gH]^{0.5})]^{0.5}$

   Where: D = orifice diameter (inches).

   Q (cfs) = WQV (cf)/(48 hr. × 60 min/hr. × 60 sec/min).

   C_d = orifice coefficient (0.62 for square-edged entrance).

   g = gravitational constant (32.2 ft./sec^2).

   H = ⅔ temporary detention height (feet) to orifice centerline.
5. Maximum depth of permanent pool = 2.5 feet.
6. Maximum velocity through the wetland should average less than 0.01 feet per second for the water quality flow. Design should distribute flow uniformly across the wetland.
7. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and shall be armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.
8. Provide for a basin dewatering system with a 24-hour maximum drawdown time.

b. Design Criteria

1. Minimum of two cells, with the first cell (forebay) at least 10% of the surface area. The forebay shall also constitute 20% of the treatment volume. Where space limits multi-cell design, use one cell with a forebay at the inlet to settle sediments and distribute flow across the wet pond.
2. Permanent pool depth to be spatially varied throughout wetland.
3. Provide a perimeter zone 10 to 20 feet wide that is inundated during storms.
4. Maximum side slopes for wetland planting = 5H:IV.
5. Maximum side slopes for non-wetland planting = 3H:IV.
6. Over excavate by a minimum of 20% to allow for sediment deposition.
7. Minimum freeboard = 1 foot from 25-year design water surface elevation.
8. Retaining walls are not allowed in the treatment area.
8. The construction of wetlands and maintenance accessibility shall be in conformance with Subsection 3.2.3, "Design Criteria," Subsection 3.3.9, "Detention/Retention Facility Protection," and Subsection 3.4.4, "Access Road Design."
9. Provide an approved outlet structure for all flows.

10.5 INFILTRATION

10.5.1 Infiltration Trench

Design criteria

a. The design of infiltration trenches is based on Darcy's Law (Safety Factor = 2):

$A = 2.0 \times Q \div (f \times i)$

Where: A = area of trench bottom (square feet).
Q = design flow rate (cfs).
f = infiltration rate of soil or infiltration media (ft./sec).
i = hydraulic gradient (see below).

$i = (h + L) \div L$

Where: h = height of water column over infiltration media.
L = distance from surface to bottom of trench

b. The infiltration trench shall infiltrate the entire water quality storm without overflow.
c. Infiltration facilities shall not be accepted in soils with a tested infiltration rate of less than 0.50 inches per hour.
d. There shall be no less than 3 feet of undisturbed depth of infiltration medium between the bottom of the facility and any impervious layer (hardpan, solid rock, high groundwater levels, etc.).
e. Drawdown time (time for the trench to empty water from the water quality storm) shall not exceed 24 hours.
f. Infiltration trenches shall meet the following setback requirements for downstream slopes: minimum of 100 feet from slopes of 16%; add 5 feet of setback for each additional percent of slope up to 30%; 200-foot setback for slopes of 30%; infiltration trenches shall not be used where slopes exceed 30%.
g. All infiltration trenches shall have an overflow installed that can transport the design capacity of the water delivery system through the facility to an approved stormwater receiving system if the facility infiltration capacity is exceeded. An approved stormwater receiving system is a stream, lake, or pond, or a storm sewer or drainage ditch. Overflows shall be designed with appropriate erosion-control devices.
h. Each trench shall have one slotted observation pipe (4-inch) that extends to the bottom of the trench, at a point approximately halfway along the trench. The observation pipe shall have a threaded or hinged cap or plug.

i. Drain medium shall have filter fabric between the medium and native soils or backfill meeting specifications established in Table 10.2.
j. Infiltration areas shall be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular construction traffic, except that specifically used to construct the facility, shall be allowed within 10 feet of infiltration trench areas.
k. A certified soils scientist (ARCPACS certification), or suitably trained person working under the supervision of a Professional Engineer registered in the State of Oregon, shall inspect the soil after the system is excavated and before trenches are filled with drain medium, to confirm that soils remain in suitable condition to perform at anticipated infiltration rates.

10.5.2 Infiltration Basin

Design criteria

a. The design of infiltration trenches is based on Darcy's Law (Safety Factor = 2):

$$A = 2.0 \times Q \div (f \times i)$$

Where: A = area of trench bottom (square feet).
Q = design flow rate (cfs).
f = infiltration rate of soil or infiltration media (ft./sec).
i = hydraulic gradient (see below).

$$i = (h + L) \div L$$

Where: h = height of water column over infiltration media.
L = distance from surface to bottom of trench

b. The infiltration basin shall infiltrate the entire water quality storm without overflow.
c. Infiltration basins shall meet the following setback requirements for downstream slopes: minimum of 100 feet from slopes of 10%; add 5 feet of setback for each additional percent of slope up to 30%; 200-foot setback for slopes of 30%; infiltration trenches shall not be used where slopes exceed 30%.
d. All infiltration basins shall have an overflow installed that can transport the design capacity of the water delivery system through the facility to an approved stormwater receiving system if the facility infiltration capacity is exceeded. An approved stormwater receiving system is a stream, lake, or pond, or a storm sewer or drainage ditch. Overflows shall be designed with appropriate erosion-control devices.
e. Any imported drain medium shall have filter fabric between the medium and native soils or backfill.
f. Two staff gauges shall be installed, at opposite ends of the bottom of the basin, to enable maintenance staff to measure the depth of accumulated silts.
g. Infiltration areas shall be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, shall be allowed within 10 feet of infiltration basin areas.
h. A certified soils scientist (ARCPACS certification), or suitably trained person working under the supervision of a Professional Engineer registered in the State of Oregon, shall inspect the soil after the system is excavated and before the basin is filled with drain medium, to confirm that soils remain in suitable condition to accept anticipated infiltration.
i. Infiltration facilities shall not be accepted in soils with a tested infiltration rate of less than 0.50 inches per hour.
j. There shall be no less than 3 feet of undisturbed depth of infiltration medium between the bottom of the facility and any impervious layer (hardpan, solid rock, high groundwater levels, etc.).
k. Drawdown time (time for the basin to empty water from the water quality design storm) shall not exceed 24 hours.

SECTION 11 – STORMWATER QUALITY FACILITY LINERS

11.1 INTRODUCTION

The purpose of this Section is to provide guidelines for the design and construction of stormwater quality facilities in the City of Molalla.

11.2 STORMWATER QUALITY FACILITY LINERS

Liners are intended to reduce the likelihood that pollutants in stormwater will reach groundwater when water quality facilities are constructed. In addition to groundwater protection considerations, some facility types require permanent water for proper functioning. An example is the first cell of a wet pond.

Treatment liners amend the soil with materials that treat stormwater before it reaches more freely draining soils. The liners have slow rates of infiltration, generally less than 2.4 inches per hour (1.7×10^{-3} centimeters per second [cm/s]), but not as slow as low-permeability liners. Treatment liners may use in-place native soils or imported soils. Low-permeability liners reduce infiltration to a very slow rate, generally less than 0.02 inches per hour (1.4×10^{-5} cm/s). These types of liners should be used for industrial or commercial sites that have a potential for high pollutant loading in stormwater runoff. Low-permeability liners may be fashioned from compacted till, clay, geomembrane, or concrete. Till liners are preferred because of their general resilience and ease of maintenance.

11.2.1 General Design Criteria

a. **Table 11.1** shows recommendations for the type of liner generally best suited for use with various water quality facilities.
b. Liners shall be evenly placed over the bottom or sides of the treatment area of the facility, as shown in **Table 11.1**. Areas above the treatment volume that are required to pass flows greater than the water quality flow (or volume) need not be lined. However, the lining must extend to the top of the interior side slope and be anchored, if it cannot be permanently secured by other means.

Table 11.1. RECOMMENDED LINERS FOR STORMWATER FACILITIES

Type of Facility	Area to Be Lined	Recommended Liner
Pre-settling basin	Bottom and sides	Low-permeability liner or treatment liner. (If basin will intercept seasonal high groundwater table, treatment liner is recommended.)
Wet pond	First cell: bottom and sides to water quality design water surface	Low-permeability liner or treatment liner. (If wet pond will intercept seasonal high groundwater table, treatment liner is recommended.)
	Second cell: bottom and sides to water quality design water surface	Treatment liner

Combined detention/ water quality Facility	First cell: bottom and sides to water quality design water surface Second cell: bottom and sides to water quality design water surface	Low-permeability liner or treatment liner. (If facility will intercept seasonal high groundwater table, treatment liner is recommended.) Treatment liner
Constructed treatment wetland	Bottom and sides, both cells	Low-permeability liner. (If facility will intercept seasonal high groundwater table, treatment liner is recommended.)
Sand filtration basin	Basin sides only	Treatment liner
Sand filter vault	Not applicable	No liner needed
Media filter (in vault)	Not applicable	No liner needed
Wet vault	Not applicable	No liner needed

c. For low-permeability liners, the following criteria apply:
    1. Where the seasonal high groundwater elevation is likely to contact a low-permeability liner, liner buoyancy may be a concern. A low-permeability liner shall not be used unless evaluated and recommended by a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering.
    2. Where the design calls for grass to be planted over a low-permeability liner, a minimum of 6 inches of good topsoil or compost-amended native soil (2 inches compost tilled into 6 inches native till soil) must be placed over the liner in the area to be planted; 12 inches of cover is preferred.

11.2.2 Interference with Seasonal Groundwater

If a treatment liner will be below the seasonal high-water level, the liner's pollutant-removal performance must be evaluated by a qualified professional, and the liner's placement must be found as protective as if the liner were above the level of the groundwater. A qualified professional shall be either a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering, a Certified Engineering Geologist registered in the State of Oregon, or a Professional Hydrogeologist registered in the State of Oregon.
See Subsection 11.3, "Stormwater Quality Treatment Liners" and Subsection 11.4, "Low-Permeability Liner Options", below for more specific design criteria for treatment liners and low-permeability liners.

11.3 STORMWATER QUALITY TREATMENT LINERS

Design Criteria

a. A 2-foot-thick layer of soil with a minimum organic content of 5% and a minimum CEC of 5 millequivalents/100 grams can be used as a treatment layer beneath a water quality or quantity facility.
b. To demonstrate that in-place soils meet the above criteria, one sample per 1,000 square feet of facility area shall be tested. Each sample shall be a composite of subsamples taken throughout the depth of the treatment layer (usually 2 to 6 feet below the expected facility invert).

c. Typically, sidewall seepage is not a concern if the seepage flows through the same stratum as the bottom of the stormwater facility. However, if the treatment soil is an engineered soil or has very low permeability, the potential to bypass the treatment soil through the sidewalls may be significant. In those cases, the stormwater facility sidewalls should be lined with at least 18 inches of treatment soil, as described above, to prevent untreated seepage. This lesser soil thickness is based on unsaturated flow as a result of alternating wet and dry periods.
d. Organic content shall be measured on a dry-weight basis using ASTM D-2974.
e. CEC shall be tested using EPA laboratory method 9081.
f. Certification that imported soil meets the organic content and CEC criteria above shall be provided to the local approval authority by a soils-testing laboratory.
g. Animal manures used in treatment soil layers must be sterilized because of the potential for bacterial contamination of groundwater.

11.4 LOW-PERMEABILITY LINER OPTIONS

This section specifies the design criteria for four low-permeability liner options: compacted till liners, clay liners, geomembrane liners, and concrete liners.

11.4.1 Compacted Till Liners

a. Liner thickness shall be 18 inches after compaction.
b. Soil shall be compacted to 95% of the maximum dry density, as determined by AASHTO T-180.
c. A different depth and density sufficient to retard the infiltration rate to 2.4×10^{-5} inches per minute (1×10^{-6} cm/s) may also be used instead of Criteria 1 and 2.
d. Soil should be placed in 6-inch lifts.
e. Gradation requirements of the soil shall be as indicated in **Table 11.2**. Sieve analysis shall be determined according to AASHTO T-27.

Table 11.2. SOIL GRADATION REQUIREMENTS, COMPACTED TILL LINERS

Sieve Size	Percent Passing
6-inch	100
4-inch	90
No. 4	70-100
No. 200	20

11.4.2 Clay Liners

a. Liner thickness shall be 12 inches.
b. Clay shall be compacted to 95% of the maximum dry density, as determined by AASHTO T-180.
c. A different depth and density sufficient to retard the infiltration rate to 2.4×10^{-5} inches per minute (1×10^{-6} cm/s) may also be used instead of the above criteria.
d. The slope of clay liners must be restricted to 3H: IV for all areas requiring soil cover. Otherwise, the soil layer must be stabilized by another method so that soil does not slip into the facility. Any alternative soil-stabilization method must take maintenance access into consideration.

e. Where clay liners form the sides of ponds, the interior should not be steeper than 4H:1V, irrespective of fencing. This restriction is to ensure that anyone falling into the pond can climb out.
f. Specification requirements of the clay soil shall be as indicated in **Table 11.3**.

Table 11.3. SPECIFICATIONS FOR SOIL IN CLAY LINERS

Property	Test Method	Unit	Specification
Permeability	ASTM D-2434	cm/sec	1×10^{-6}
Plasticity Index of Clay	ASTM D-423 & D-424	percent	Not less than 15
Liquid Limit of Clay	ASTM D-2216	percent	Not less than 30
Clay Particles Passing	ASTM D-422	percent	Not less than 30
Clay Compaction	ASTM D-2216	percent	95% of Max. Dry Density, AASHTO T-99

11.4.3 Geomembrane Liners

a. Geomembrane liners shall be ultraviolet (UV) light resistant and have a minimum thickness of 30 mils. A thickness of 40 mils shall be used in areas of maintenance access or where heavy machinery must operate over the membrane.
b. Liners shall be bedded according to the manufacturer's recommendations.
c. Liners shall be installed so that they can be covered with 12 inches of top dressing forming the bottom and sides of the water quality facility, except for liner sand filters. Top dressing shall consist of 6 inches of crushed aggregate covered with 6 inches of native soil. The aggregate layer is to mark the location of the liner for future maintenance. As an alternative to crushed aggregate, 12 inches of native soil may be used if orange plastic safety fencing or another highly visible, continuous marker is embedded 6 inches above the membrane.
d. If possible, liners should be of a contrasting color so that maintenance workers are aware of any areas where a liner may become exposed when maintaining the facility.
e. Geomembrane liners shall not be used on slopes steeper than 5H:1V to prevent the top-dressing material from slipping. Textured liners may be used on slopes up to 3H:1V, provided that a Professional Engineer registered in the State of Oregon, whose area of expertise is geotechnical engineering, recommends that the top dressing will be stable for all site conditions, including maintenance.

11.4.4 Concrete Liners

a. Portland cement liners are allowed irrespective of facility size, and shotcrete may be used on slopes. However, specifications must be developed by a Professional Engineer registered in the State of Oregon who certifies the liner against cracking or losing water retention ability under expected conditions of operation, including facility maintenance operations. Maintenance equipment can weigh up to 80,000 pounds when fully loaded.
b. AC may not be used for liners because of its permeability to organic pollutants.
c. If grass is to be grown over a concrete liner, slopes must be no steeper than 5H: IV to prevent the top dressing from slipping.